Electrical Review

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLII. No. 26. NEW YORK, SATURDAY, JUNE 27, 1903. ISSUED WEEKLY

ELECTRICAL REVIEW

13 to 21 Park Row NEW YORK

BY THE

ELECTRICAL REVIEW PUBLISHING COMPANY

CHARLES W. PRICE . . . . PRESIDENT and EDITOR
STEPHEN H. GODDARD . SECRETARY and MANAGER
RUSSELL HOWLAND . GENERAL REPRESENTATIVE
WM. HAND BROWNE, JR. . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

WESTERN OFFICE—40 Dearborn Street, Chicago, Ill. CHARLES FFRENCH, Manager.

EUROPEAN OFFICE—42 Old Broad Street, London, E. C. HENRY W. HALL, Manager.

TELEPHONE CALL (private branch exchange connecting all departments)—"21 Cortlandt."

REGISTERED CABLE ADDRESS—"Electview," New York.

SUBSCRIPTIONS

One Year, United States and Canada	$3.00
One Year, Foreign Countries	5.00
Single Copies, each	10
Copies supplied for only one year back, each	25

N-RAYS.

The new kind of light discovered by M. R. Blondlot and named by him "N-rays," after the University of Nancy, where the work was carried out, promises to be of great value as soon as means has been devised for making use of its peculiar properties. These rays were first discovered by the effect produced upon small electric sparks in air and were obtained from a Rœntgen-ray tube. They penetrate aluminum, black paper and other materials, as do Rœntgen rays, but they can be refracted and reflected, though they exert no photographic action. Since the first discovery, M. Blondlot has found that they were given off by other bodies, such as silver or talc heated to redness, and an ordinary circular gas flame burning without a chimney. He has found that they can be detected by their action upon a phosphorescent screen of calcium sulphide, as this shows a notable increase of phosphorescence under their influence. They also affect incandescent gas, so that a small body of this shows an increase in luminosity.

ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The twentieth annual convention of the American Institute of Electrical Engineers will be held at Niagara Falls, N. Y., the week beginning June 29.

Railroad Papers.

Tuesday morning will be devoted to railroad papers, and the Wednesday morning session to power transmission papers. Several of the railroad papers are on phases of that work which have been more or less prominent for the last year or two. The value of the storage battery has been under discussion, and this will receive further attention at the meeting. The problems introduced by high-speed running are being studied, both in this country and abroad, and a paper discussing these will be presented.

Transmission Papers.

At the session devoted to transmission papers, will be presented another group of introductions. It is to be hoped that these introductions will provoke thorough and valuable discussion. The introductions have already appeared in the technical papers, and there is no reason why every engineer who is interested in the subject of electrical power transmission should not be familiar with their contents. The members of the Transmission Committee have spent much time and thought in preparing these introductions, but the full value of their work can only be realized by a general, broad discussion. In addition to these papers there are others—some scientific and some purely technical—which promise to be of particular value.

Social Features.

The social side of the convention has been planned with especial care. Visits will be made to the industrial plants in the locality, and to other points of interest. The convention, as a whole, promises to be most successful, and there will doubtless be a good attendance.

THE ENGINEERING BUILDING.

Events are gradually shaping themselves so that the co-operation of the engineering societies in accepting Mr. Carnegie's gift of an engineering building seems fairly well assured. The board of managers of the American Institute of Electrical Engineers has been authorized to join with the other societies in this undertaking. The council of the American Society of Mechanical Engineers has taken such action in favor of the project as was authorized, but definite action can only be secured by a vote of the members. The society seems to be in favor of the plan. The council of the American Institute of Mining Engineers has taken action looking toward co-operation with the other societies, subject to the approval of the members, but the members of the council have, over their individual signatures, issued a request to the members of the Institute asking for an expression of opinion on the matter.

The American Institute of Civil Engineers, at the recent convention at Nashville, N. C., discussed the proposition at some length. Some strong opposition to co-operation with the other societies was manifested. Resolutions were passed authorizing the board of direction to ascertain whether suitable accommodations can be obtained, and if it is satisfied in this matter, that the proposition be submitted to the society by letter votage. These resolutions are to be presented to the society with sixty days' notice and opportunity afforded for discussion at the next annual meeting. This resolution will postpone action of the society until some time in 1904, and as the option on the site on Thirty-ninth street, on which Mr. Carnegie has already paid $50,000, expires on the first of July, this is rather unfortunate. It is to be hoped that the board of direction will find some way out of this difficulty and that the matter may be settled by the members, without unnecessary delay.

THE PRACTICE OF PHOTOMETRY.

The science of photometry has certain peculiarities which make its study and practice difficult and, except under the best conditions, unsatisfactory. Light, using the term in its restricted sense, includes only those ether vibrations which produce a certain physiological effect, and although these same vibrations are capable of bringing about other actions, such as affecting a photographic plate, the only true method of measuring light must depend upon the effect produced on the human eye. Each observer, therefore, uses a different instrument, and the accuracy of his work must depend not only upon his skill and training, but also upon the sensitiveness of his eye.

Photometric Methods.

Added to this complicating circumstances is the difficulty caused by the way in which measurements must be made. It is not possible to measure light as one measures distances or weights, by bringing the unknown up to a standard and determining accurately the ratio between them. While a trained eye can judge whether a certain distance is equal to or greater than another, and if greater, how many times greater, the same eye can not compare two lights of different intensity and estimate the ratio between them. The eye can recognize that the lights are different, and whether there is a large or a small difference, but it is incapable of estimating how many times greater the one is than the other. Measurements of light are limited to the one case where the effect produced upon the eye by the two sources is the same. This necessary condition is usually met by illuminating two surfaces by the two sources of light, and varying one or both illuminations until the eye judges them to be the same.

The Principle of the Photometers.

This is the principle of nearly all photometers. Two surfaces as nearly identical as possible are prepared. Light from an accepted standard is allowed to fall upon one, the second being illuminated by the source of light to be measured. The illumination on one or both surfaces is then varied by various means till, in the opinion of the observer, the two surfaces are equally illuminated. When this has been done the ratio of the two sources of light is determined according to the method used to vary the intensity of illumination. In the greater number of photometers this variation is brought about by altering the distance from the illuminated surfaces to one or both illuminants. In some instances each surface may receive light from both sources.

Disturbing Influences.

For measurements of this kind, where no disturbing influences come in, the eye is quite sensitive. While it can not judge of the relative intensity of two illuminants, it recognizes easily any difference, if a difference exists. Unfortunately, however, it is very difficult to eliminate disturbing factors. Light falling on the observer's eye from a source other than the surfaces being compared, will probably cause serious errors, even though it does not fall on the photometer screen, as the illuminated surfaces are called.

Difficulties Due to Color.

Another, and a very serious difficulty in photometric work, is caused by the different qualities of light emitted by the standard and that to be tested. It is extremely puzzling to say which of two illuminations that are nearly equal, but of a different color, is the greater. Some persons are more sensitive to light of one color, and would naturally give that color the advantage so far as they personally are concerned, and very properly so; but determinations made by others would probably differ very materially from theirs.

Errors Caused by Fatigue.

Another source of error, and one which should be carefully guarded against, is due to the fatigue of the observer. After a prolonged use of photometric measurements the eye becomes dulled, and no longer judges as accurately as when the work was first started. Errors due to this cause should be reduced to a minimum by relieving the observer of all other work, and stopping the work as soon as fatigue is felt. It is for the latter reason that, in general, it will be found that a photometer which is less fatiguing will, in the long run, give more satisfactory results than one which is more sensitive at the beginning of the work, but tires the eye more quickly.

Changes in the Illuminant Itself.

But although the dependence of the photometrist upon his eye and judgment makes the work difficult, his troubles do not end here. Some—probably all—illuminants exhibit a certain fatigue which, unless guarded against, may spoil work which otherwise has been carried out most carefully. At the recent convention of the National Electric Light Association, Professor H. E. Clifford, of the Massachusetts Institute of Technology, called attention to this phenomenon as observed in a Nernst lamp. He has found that the light from several of these lamps did not reach a constant value until the lamp had been burning for fifty minutes. Therefore, unless the lamp to be tested had been burned that length of time before measurements were begun, the readings made could not be compared with each other. Professor Clifford found also that the Nernst lamp, which is particularly sensitive to changes in voltages, does not recover its normal candle-power for some minutes after the voltage is returned to the normal. It is possible that the ordinary incandescent lamp, if not many other illuminants, would show a similar effect, though probably of shorter duration. It is well known that the amyl acetate standard is very sensitive to external influences, and since the energy given off as light in any case is but a small fraction of the total energy radiated, any action which affects the temperature of the glowing body must produce a marked effect in the quantity of light radiated.

Another Troublesome Phenomenon.

Professor Clifford also called attention to another phenomenon which his experiments seem to indicate may be a source of error in photometric measurements, when the two illuminants give a light of different quality. This is known as the Purkinje effect, which is observed if two lights, one having a blue and the other a yellow tinge, are balanced in a photometer. If then the illumination on both sides of the screen is changed equally, the lights no longer appear to be balanced. If the lights are balanced at a mean distance,

and then both be brought closer to the photometer, the yellow appears to increase more rapidly in intensity than the blue. If, on the other hand, the light be moved away, the bluish light appears to decrease less rapidly than the yellow. He found that by varying the illumination on the photometric screen, he could vary the ratio between the two illuminants by fifty per cent. This difference was so large that Professor Clifford hesitated to attribute it to the above effect; but there seems to be no other explanation for it. From this it would seem advisable that in making photometric measurements, the intensity of the illumination on the screen should be known and stated. It is usual, in comparing lights of different tints, to make the illumination of the screen as low as possible, as under this condition there is less difficulty in securing a satisfactory setting of the photometric screen. But this raises the question whether measurements made in this way are entirely fair to lamps giving a yellowish light, since in practical lighting something more than a faint illumination is required.

Practice of Photometry.

It is evident from the above that the practice of photometry requires careful training and patient and painstaking work, since much more here depends upon the judgment of the observer than is true for other practical testing. Nevertheless, under favorable conditions, this work can be done with sufficient accuracy for all practical purposes, as was clearly demonstrated by Dr. Clayton H. Sharp, before the American Institute of Electrical Engineers last fall, and his opinion is strongly supported by Professor C. P. Matthews, of Purdue University, who has had charge of the photometric work for the National Electric Light Association for the past four years. The work should be entrusted only to specialists who have been carefully trained. It is impossible to devote as much time to the subject of photometry in the electrical engineering courses as would make the students expert photometrists, even if this were desirable; but the student should be aware of the principles of the subject and the difficulties which hedge about its practical application, in order that he may guard against the error of putting too much dependence upon the average photometric measurements.

METHODS OF COMBINING RESISTANCES—II.

BY EDWIN F. NORTHRUP.

Fig. 14 shows a form of commutator with surface developed which will make the above connections in the manner indicated.

An extra segment is shown in dotted line, and an extra 1-ohm coil which may be used for running the series up to ten ohms if required.

Since the resistance coils have no free terminals it is a matter of indifference whether the commutator is stationary and the brushes move over the commutator, or the brushes are kept stationary and the commutator, carrying the coils rigidly attached to it, is moved under the brushes. By using the latter method it is not necessary to have any flexible cords connected to the brushes or the current taken into them by sliding contacts.

By an extension of the above method, a precision rheostat may be made which will consist of commutators for the units, tens, hundreds and thousands, place, etc., the stationary brushes of all the commutators being directly connected in series. Fig. 15 shows diagrammatically a rheostat of four decades.

Similar results can be obtained by combining four coils of the values 1, 2, 3 and 6, and any multiples of these numbers.

The writer has constructed rheostats on this principle for use with portable testing sets, which gave all the results to be obtained with ordinary plug decade sets using 9 or 10 coils to the decade. It is not the purpose of this paper to give any mechanical constructions, but it may be stated that brush contacts, when properly made, will have a lower resistance than even plug contacts.

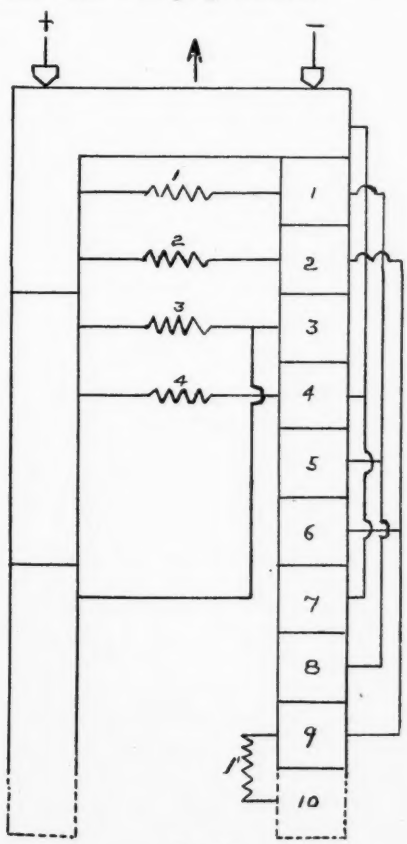


FIG. 14.

SOME FURTHER GENERAL REMARKS ON COMBINING RESISTANCES.

The object sought in the construction of all resistance boxes for precision rheostats or Wheatstone bridges, is to arrange for obtaining the greatest possible number of values of resistance from the fewest possible number of resistance coils. It is further sought to arrange the boxes in such a way that the series of values which can be obtained may be easily added in any combination. If it were not sought to accomplish these two ends, there would be no such thing as resistance boxes, as a single coil, adjusted to the desired precision, could be used for each value of resistance required or a few separate coils with terminals could be connected in a great variety of ways to give a great number of integral and fractional values of resistance. Generally the number of values of resistance which can be obtained by combining a number of coils of different values can not be calculated from the number of combinations which can be made of these coils in series or in parallel, for many of the different combinations of the coils give the same values of resistance. Thus we can combine the coils 1, 2, 3 and 4 ohms in series in $2^4 - 1 = 15$ different ways, but in five cases the same values of resistance are repeated, so that out of these coils, by connecting them in series, only ten different values of resistance can be obtained.

The total number of different values of resistance which a given number of coils will give in any particular case is a complex problem if the number of coils be large. If the coils are connected in all possible ways as, taken singly, joined in series, in parallel, in series-parallel, and in all possible mixed arrangements of series and parallel, a very great number

of resistance values can be obtained when the coils have different values. Thus, two coils can be connected in four different arrangements, that is, each coil can be taken singly, two coils can be taken in series and in parallel. From three coils seventeen arrangements can be made and from four coils 106 arrangements. Thus it is often possible when one has at his disposal only a few standards of resistance, to obtain a very great number of known values of resistance.

Resistance boxes constructed on several different plans have long been used for making the combinations simply and expeditiously. We will briefly review the standard methods employed for the construction of resistance boxes and then give some new methods which we have devised.

STANDARD METHODS USED IN THE CONSTRUCTION OF RESISTANCE BOXES.

SIEMENS' PLAN.

The following plan of forming the rheostat of a resistance box was proposed by Siemens. Coils are joined between blocks in the manner indicated and having the values shown in Fig. 16.

Resistance is thrown in circuit by removing plugs from between the blocks to which the coils are attached. The advantage of the plan is that it employs the smallest possible number of coils for obtaining a given number of values of resistance.

This is because as many values of resistance will be obtained from a given number of coils having the series of values 1, 2, 4, 8, 16, etc., as the total number of combinations which can be formed of the coils used. Thus, from the coils 1, 2, 4 and 8, fifteen possible combinations can be formed, and fifteen values of resistance will be obtained by joining the coils in series. The arrangement further permits of ready comparison of each coil with others of the series, provided the box is supplied with an extra one-ohm coil. Thus the coil $8 = 1^1 + 1 + 2 + 4$, the coil $32 = 1^1 + 1 + 2 + 4 + 8 + 16$.

The arrangement has the disadvantage that the values unplugged can not be quickly and easily summed up to obtain the total value.

To offset this disadvantage it was proposed to employ the so-called "binary scale" invented by Leibnitz. In this scale two figures 0 and 1 only are used, the 0 denoting multiplication by 2. Thus the first ten numbers would be expressed by this scale as follows:

$$
\begin{aligned}
1 &= \quad 1 = 2^0 \\
2 &= \quad 10 = 2^1 \\
3 &= \quad 11 = 2^1 + 1 \\
4 &= \quad 100 = 2^2 \\
5 &= \quad 101 = 2^2 + 1 \\
6 &= \quad 110 = 2^2 + 2 \\
7 &= \quad 111 = 2^2 + 2 + 1 \\
8 &= 1000 = 2^3 \\
9 &= 1001 = 2^3 + 1 \\
10 &= 1010 = 2^3 + 2
\end{aligned}
$$

To denote by means of this scale the coils unplugged and their total value, we indicate every plug removed by 1, and every plug left in by 0. Thus if the coils not in brackets are unplugged as $64 + 32 + [16] + 8 + [4] + [2] + 1$, we write 1101001 = 105.

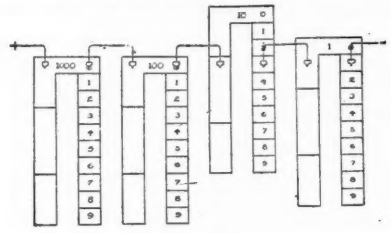


FIG. 15.

As few persons, however, are familiar with the binary scale, this method of Siemens is not practical and has now become obsolete.

OTHER PLANS.

There are three sets of numbers which will add up to ten and which will give ten consecutive values.

THE 1 — 2 — 3 — 4 PLAN.

This set of numbers gives all values from one to ten in steps of one ohm. Likewise all values up to 100 in steps of ten ohms may be obtained from the coils 10 — 20 — 30 — 40, all values up to 1,000 in steps of 100 ohms by the coils 100 — 200 — 300 — 400, etc. Boxes are commonly constructed on this plan with the following coils; 1 — 2 — 3 — 4 —20—30—40—200—300—400, etc.

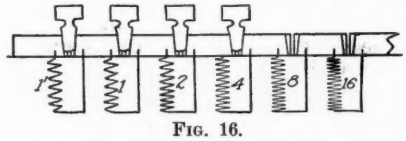


FIG. 16.

The coils mentioned making a rheostat having the capacity of 1,000 ohms which can be varied in steps of one ohm. As a matter of convenience the 10, the 100, the 1,000, etc., ohm coils are often added to the above series. In the above arrangements of coils, in which the coils are connected in series and joined to blocks in the manner shown in the last figure, as many plugs must be used as there are coils in the rheostat. The needed values are obtained by withdrawing plugs, as many plugs being withdrawn as there are coils to throw in circuit.

THE 1 — 2 — 2 — 5 PLAN.

Coils having the values 1 — 2 — 2 — 5, 10 — 20 — 20 — 50, etc., are used in precisely the same way as in the arrangement mentioned above. By far the greatest number of resistance boxes used have rheostats on one or the other of the above plans.

The writer does not know that there is any particular choice between the two above mentioned plans.

THE 1 — 1 — 3 — 5 PLAN.

All values from one to ten in unit steps can be obtained from the numbers 1 — 1 — 3 — 5. All values from 10 to 100 in steps of ten can be obtained from the numbers 10 — 10 — 30 — 50. All values from 1 to 1,000 in steps of one can be obtained from the numbers 1 — 1 — 3 — 5 — 10 — 30— 50 — 100 — 300 — 500. Hence a rheostat may be constructed with coils arranged according to the above plan. As a matter of fact, the writer knows of no resistance boxes which are constructed according to this plan, though there appears to be no reason why it is not as good as the two given above, which are commonly used.

REMARKS ON THE LAST THREE PLANS.

The advantages gained in any of the three above plans rest in the possibility of obtaining an endless series of values of resistance in small steps with a very small number of coils as compared with the number of values of resistance obtained, in the ease with which the values unplugged may be mentally summed up, and, it may be added, the facility with which different coils can be compared with others in the series in checking up their values. The disadvantages of the general method are the following: As many plugs must be used as there are coils. The plugs left in must all be tightly forced in between the blocks, as any single loose plug will introduce an unknown resistance, and when the smallest resistance is being used there is then the largest number of plug contacts in circuit. To these must be added the necessity of manipulating a large number of plugs wherever a new total value of resistance is required. There is the minor disadvantage also of it being necessary to dispose of the plugs removed and the greater disadvantage of having to use some mental effort in summing up the values unplugged. These disadvantages of forming the combinations of resistance coils by removing a number of plugs from between blocks have led, especially in recent years, to the adoption of other methods, which, though generally more expensive to realize in practice, are decidedly superior, as we shall attempt to show.

(To be continued.)

NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CLIX—A BREAK NOT A NECESSARY PART OF AN INDUCTION COIL.

It is frequently said in comparing static machines with coils for exciting X-light tubes that the necessary defect of the coil is the break, which makes the light too unsteady for use with the fluoroscope. Those who make this criticism forget that a break is not an essential part of an induction coil. One reason why I advocated coils of high potential for exciting X-light tubes was that such coils did not need a break, for by using an alternating current in the primary it was practical to develop sufficient potential in the secondary to excite an X-light, even though it had a low resistance. I believe Spottiswoode was the first to prove that a coil could be operated in this way for vacuum tube work. In 1879 he showed that a twenty-inch coil could be employed with an alternating current from a De Meritens dynamo in the primary. The spark from the secondary was seven inches long, the size of a cedar lead pencil, extremely steady and suitable for spectrum work without a condenser in the secondary. I found the type of coil described in notes cxii and cxxxvii suitable for these heavy discharges, as there was small danger of burning out the secondary. The secondary sections were free from each other, from the tube separating the primary, from the secondary and interchangeable. When one was injured it could be quickly replaced by another kept in reserve.

NOTE CLX—SMALL VERSUS LARGE INDUCTION COILS FOR EXCITING X-LIGHT TUBES.

It is commonly stated that large coils are not required for exciting X-light tubes because the resistance of a tube for medical work never requires it to be over three inches. Therefore to use a coil giving a higher potential than necessary to overcome this resistance is unwise, for large coils are expensive, cumbersome, and do not give a sufficient volume of current, owing to the length of fine wire in the secondary. It is well, however, to have a good memory for the work of the great experimenters. For example, Trowbridge took a photograph of the bones of the hand in a millionth of a second with a generator having sufficient potential to send the discharge across six feet of air. Until those who are advocating coils having a potential only sufficient to excite a tube of moderate resistance can make as short exposures, their arguments against high potentials are weak. At present they are giving exposures from thirty to sixty million times that mentioned. As the use of small coils is still advocated, it may be worth while to repeat some of the reasons I gave for the use of high potentials with X-light tubes.

First—When we pump a tube for X-light work we try to leave as much gas in the terminals as practical that the life of the tube may be long. Such a tube can be used some hours before it requires to have the resistance lowered by introducing fresh gas from a regulator. When a powerful discharge is sent through such a tube for more than a few minutes at a time so much gas is liberated that the resistance becomes less than one millimetre, and under these circumstances, with a coil of low potential no useful X-light can be obtained from it. If, however, the

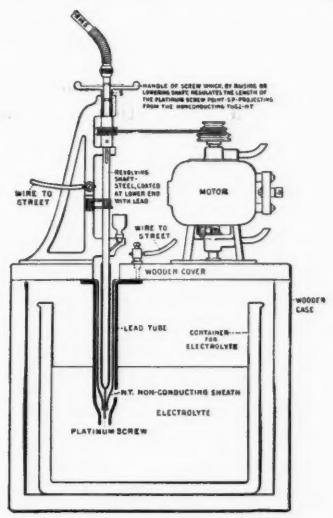


FIG. 1.—NOTE 161.

coil has a high potential (as I have advocated), by holding back the surges we can make the subatoms in the cathode stream strike the target with sufficient force to get heated enough to produce X-light of proper quality for medical work, notwithstanding the increased cloud of particles in the tube through which they must make their way. This, then, is one clear reason why high-potential coils are useful for the present. Second—Such a tube has a far longer life than one in which the terminals have been made very dry to prevent a powerful current from lowering the resistance rapidly. Third—If we attempt to use an alternating current in the primary of a small coil, in order to get a steady light by discarding the break, as mentioned in note clix, we find that the coil has a less potential and is therefore less fitted for the work. Small coils are most suitable for portable apparatus and when used the tubes should be provided with automatic regulators of the type shown in note cxxxviii, the terminals being left rather dry that the large volume of current may not lower the resistance of the tube more rapidly than can be compensated by the reabsorption of the gas first liberated from the regulator to lower the initial high resistance sufficiently to enable the current to pass.

Where two theories are held, the best way to decide upon which to follow is to push each to the extreme. When my theory of high potentials for exciting X-light tubes is pushed to the extreme we get Trowbridge's result of a very short exposure. When we follow a similar course with the other theory of low potentials we find it impossible to get an X-light photograph, no matter how long we expose, for we can not drive the subatoms in the cathode stream against the target with sufficient force to produce X-light. In connection with low potentials for use in the future, when X-light tubes shall have been perfected, it is well to remember the two following experiments by distinguished men, for they are significant as they show that coils or static machines form no necessary part of an X-light apparatus. In 1897 Dr. Williams told me he had seen Professor E. Thomson produce an abundance of X-light with one of my cooled target tubes from a dynamo. About 1900 Professor Trowbridge showed me an X-light tube brilliantly lighted by a battery current. In neither case was the voltage over twenty thousand. This could be yielded by a coil giving a spark not over two centimetres. It is evident then that a current of low voltage, easily obtained without a coil or a static machine, can produce brilliant X-light of suitable quality for medical work, provided the tubes are in proper condition. At present a difficulty is that tubes do not remain in suitable condition for the use of large currents when their potential is low.

NOTE CLXI—ON MOVING THE PLATINUM TERMINAL OF AN ELECTROLYTIC BREAK.

Soon after the German rediscovery of the Spottiswoode or electrolytic break was described in the ELECTRICAL REVIEW, I experimented with it for interrupting the current in the primary of an induction coil used to excite an X-light tube. The light was not steady enough for diagnosis with the fluorescent screen. During attempts to make it steady I tried moving the platinum point in the solution to free it from gas. I explained the idea to Mr. Heinze, who afterward utilized it in a very ingenious break. I have already described some of the methods I used for moving the electrode and now illustrate another which I made at that time. The platinum point was in the form of a screw which was revolved by a small motor. The depth of immersion was varied by a screw operated by the handle RH5 having a spiral spring like those described in earlier notes. In this way the operator could control the intensity of the X-light during an examination without removing his eyes from the image on the fluorescent screen. The figure will make the construction of the break clear.

ELECTRICAL TRANSMISSION UNDER LAND AND WATER.

BY ALTON D. ADAMS.

(Concluded.)

Where the two, three or more conductors that form a complete circuit for alternating current are included in a single metallic sheath, the inductive effects of currents in the several conductors tend to neutralize each other and the waste of energy in the sheath is in large part or entirely avoided. To neutralize more completely the tendency to local currents in their metal sheath, the several conductors of an alternating circuit are sometimes twisted together, after being separately insulated, before the sheath is put on. Distribution of power at Niagara Falls was at first carried out through single-conductor, lead-covered cables with two-phase current at 2,200 volts. One objection to this plan was the loss of energy by induced currents in the lead coverings of the cables. It was later decided to adopt three-phase distribution at 10,000 volts for points distant more than two miles from the power station. Each three-phase circuit for this purpose was made up of three conductors separately insulated and then covered with a single lead sheath, so as to avoid losses through induced currents in the latter. Underground and submarine cables for operation at high voltages are generally covered either with a continuous lead sheath or with a spiral layer of galvanized iron wire. For high-voltage work underground the lead covering is generally preferred to that of iron wire, but in submarine work cables of both sorts are employed. The lead sheath of a cable being continuous completely protects the insulation from contact with gases or liquids, while this is not the case with an outside covering of iron wires. As ducts of either tile, wood or iron form a good mechanical protection for a cable, the rather small strength of a lead sheath is not a serious objection in conduit work. Submarine cables, on the other hand, depend on their own outer coverings for mechanical protection and may be exposed to forces that would rapidly cut through a lead sheath. Cables for operation under water should usually be covered, therefore, with a layer of galvanized iron wires. These wires are laid closely about the cable in spiral form and are usually between 0.12 and 0.25 inch in diameter each, depending on the size of the cable and its location.

Underground conduits can not be relied on to exclude moisture and acids of the soil from the cables which they contain, and either of these agents may lead to destructive results. If cables insulated with rubber, but without a protecting covering outside of it, are laid in underground conduits, the rubber is apt to be rapidly destroyed by fluids and gases that find their way into the conduit. If a plain lead-covered cable is employed the acids of the soil attack it, and if stray electric currents from an electric railway find the lead a convenient conductor it is rapidly eaten away where they flow out of it. To avoid both of these results the underground cable should have a lead sheath and this sheath should be protected in turn by an outside layer of hemp or jute treated with asphaltum. Lead-covered submarine cables are more reliable if they have outside windings of jute cord treated with asphaltum, and this sort of outside covering is also desirable for submarine cables that have a spiral layer of galvanized iron wires.

Rubber, paper and cotton are extensively used as insulation for underground and submarine cables, but the three are not usually employed together. As a rule, the insulation is applied separately to each conductor, and then an additional layer of insulation may or may not be located about the group of conductors that go to make up the cable. Where rubber insulation is employed, a lead sheath may or may not be added, but where insulation depends on cotton or paper the outer covering of lead is absolutely necessary to keep out moisture. The radial thickness of insulation on each conductor and of that about the group of conductors in a cable should vary according to the voltage of operation.

Cables employed between the generating and substations of the Manhattan Elevated Railway, to distribute three-phase current at 11,000 volts, are of the three-conductor type, rubber insulated, lead covered, and laid in tile conduits. Each cable contains three No. 000 stranded conductors, and each conductor has its own insulation of rubber. Jute is laid on to give the group of conductors an outer circular form, and outside of the group a layer of insulation and then a lead sheath is placed. Outside diameter of this cable is nearly three inches, and the weight nine pounds per linear foot.

The 11,000-volt, three-phase current from Niagara Falls is distributed from the terminal house to seven substations in Buffalo through about thirty miles of rubber-insulated and eighteen miles of paper-insulated, three-conductor, lead-covered cables, all in tile conduits. In each cable the three No. 000 stranded conductors are separately insulated and then twisted into a rope with jute yarn laid in to give an even round surface for the lead sheath to rest on. A part of the rubber-insulated cables have each conductor covered with nine-thirty-seconds inch of thirty per cent pure rubber compound, and the remaining rubber cables have eight-thirty-seconds-inch covering on each conductor of forty per cent pure rubber compound. The paper-insulated cable has thirteen-sixty-fourths inch of paper around each conductor, and also another thirteen-sixty-fourths inch of paper covering about the group of three conductors and next to the lead sheath. In outside diameter the rubber-insulated cable is two and three-eighths inches, and of the paper-insulated cable two and five-eighths inches, the radial thickness of the lead sheath being one-eighth inch in each case. It is reported that the cables insulated with nine-thirty-seconds inch of the mixture, said to be thirty per cent pure rubber, have proved to be more reliable than the cables insulated with eight-thirty-seconds inch of a mixture said to be forty per cent pure rubber.

The six miles of underground cables that carry three-phase, 25,000-volt current in St. Paul are of the three-conductor type, lead covered and laid in tile conduit. One of the two three-mile cables is insulated with rubber and the other with paper. In the former cable each conductor is separately insulated with a compound containing about thirty-five per cent of pure rubber and having a radial thickness of seven-thirty-seconds inch. The three conductors after being insulated are laid up with jute to give a round surface, tape being use to hold them together, and then a rubber cover five-thirty-seconds inch thick is placed about the group, after which comes the lead sheath over all. In the three miles of paper-insulated cable each conductor is separately covered with paper to a thickness of nine-thirty-seconds inch, then the three conductors are laid together with jute and taped, and next a layer of paper four-thirty-seconds inch thick is put on over the group. Outside of all comes the lead sheath, which has an outer coating of tin. The paper insulation in these cables was saturated with a secret insulating compound. The lead sheath on both the rubber and paper insulated cables is one-eighth inch thick and the sheath of the former contains three per cent of tin. Each of the three conductors in each cable consists of seven copper strands and has an area of 660,000 circular mils. Outside of the lead sheath each of these cables has

a diameter of about two and one-quarter inches. By the manufacturer's contract these cables were tested up to 40,000 volts before shipment, and might be tested up to 30,000 volts in their conduits during any time within five years from their purchase. In first cost the cable with rubber insulation was said to be about fifty per cent more expensive than the cable in which paper was used.

Underground cables in which the separate conductors are covered with cotton braid treated with an insulating compound, and then the group of conductors going to make up the cable enclosed in a lead sheath, are extensively used in Austria and Germany. For cables that operate at 10,000 to 12,000 volts the radial thickness of cotton insulation on each conductor is said to be within three-sixteenths inch, and these cables are tested up to 25,000 volts by placing all of the cable except its ends in water, and then connecting one end of the 25,000-volt circuit to the water and the other end to the conductors of the cable.

A test on the paper-insulated cable at St. Paul showed its charging current to be 1.1 amperes at 25,000 volts for each mile of its length. For the cable with rubber insulation the charging current per mile of length was found to be about twice as great as the like current for the paper cable. Each of the two overhead transmission lines connected with these cables consisted of three solid copper wires with an area of 66,000 circular mils each, and all three so mounted on the poles as to form the corners of an equilateral triangle twenty-four inches apart. The charging current of one of these three-wire, overhead circuits was found to be about 0.103 ampere per mile, at 25,000 volts, or a little less than one-tenth of the like current for the paper cable. These tests were made with three-phase current of sixty cycles per second.

Where overhead transmission lines join underground or submarine cables, either with or without the intervention of transformers, lightning arresters should be provided to intercept discharges of this sort that come over the overhead wires. Lightning arresters were provided in the terminal house at Buffalo, where the 22,000-volt overhead lines feed the 11,000-volt cables through transformers, also at the terminal house in St. Paul, where the 25,000-volt overhead lines are electrically connected to the underground cables. If an underground or submarine cable connects two portions of an overhead line, as in the Portsmouth and Dover transmission above mentioned, lightning arresters should be provided at each end of the cable as was done in that case. One advantage of a high rather than a low voltage on underground cables, where power is to be transmitted at any given rate, lies in the fact that the amperes flowing at a fault in the cable determine the destructive effect there, rather than the voltage of the transmission. It is reported that a fault or short-circuit in one of the 11,000-volt cables at Buffalo usually melts off but little lead at the sheath and does not have enough explosive force to injure the cable or its duct.

Ozone seems to destroy the insulating properties of rubber very rapidly, and as it is well known that the silent electric discharge from conductors at high voltages develops ozone, care should be taken to protect rubber insulation from its action. At the ends of cables operating at high voltages, where connections are made with switches or other apparatus, there rubber insulation is exposed to the action of ozone that is developed by the silent electric discharge between the cable conductors and its lead sheath. To protect the rubber at such points it is the practice to solder a brass cable head or terminal bell to the lead sheath near its end, this head having a diameter perhaps twice as great as that of the sheath, and then to fill the space about the cable conductors in this head with an insulating compound. Heads of this sort were used on the 11,000-volt cables at Buffalo as well as on the 13,500-volt cable in the Portsmouth and Dover transmission.

As insulating materials, whether rubber, cotton or paper, may be impaired or destroyed by heat, it is necessary that the temperature of undergrounded cables under full load be kept within safe limits. Rubber insulation can probably be raised to 125 or 150 degrees Fahrenheit without injury, and paper and cotton may go a little higher. For a given size and make of leaded cable the rise of temperature in its conductors above that of the surrounding air, for a given loss in watts per foot of the cable, may be determined by computation or experiment. The next step is to find out how much the temperature of the air in the conduits where the cable is to be used will rise above the temperature of the earth in which the conduits are laid, with the given watt loss per foot of cable. On this point there is but little experimental data. Obviously, the material of which ducts are made, the number of ducts grouped together with cables operating at the same time and the extent to which ducts are ventilated must have an important bearing on this question. At Niagara Falls some tests were made to show the rise of air temperature in a section of thirty-six-duct conduit lying between two manholes about 140 feet apart. For the purpose of this test twenty-four of the thirty-six ducts in the conduit had one No. 6 drawing-in wire passed through each of them. These twenty-four wires were connected into three groups of eight wires each, so that one group was all in ducts next to the surrounding earth, another group was one-half in ducts next to the earth and the other half in ducts separated from the earth by at least one duct, while the third group of wires was entirely in ducts separated from the earth by at least one duct. It was found that when enough current was sent through these wires to represent a loss of 5.5 watts per foot of ducts in which they were located, the rise of temperature in the air of the ducts next to the earth was about 108 degrees Fahrenheit above that of the earth. For the ducts separated from the earth by at least one other duct the rise in temperature of contained air was 144 degrees Fahrenheit above the earth. If the earth about the ducts reached seventy degrees in hot weather, the temperature of air in the inner ducts with a loss of 5.5 watts per duct-foot would thus be 214 degrees. This temperature is too high for either rubber, cotton or paper insulation, to say nothing of the amount by which the temperature of the conductors and insulation of a cable in operation must exceed that of the surrounding air in its duct. The cables actually installed in the ducts just considered were designed for a loss of 2.34 watts per foot, which probably resulted in a temperature rise well within safe limits. As the No. 6 wire used in the test did not nearly fill each duct as a cable would do, it would be very interesting to know how much ventilation took place while the test was going on. Unfortunately this point was not reported. Many of the above facts as to the St. Paul transmission are drawn from a paper by Henry Floy, in Vol. xvii, American Institute Electrical Engineers.

Facts as to the Niagara Falls and Buffalo transmission have been drawn from papers by Lewis B. Stillwell, Henry Gordon Stott and Harold W. Buck, in Vol. xviii, American Institute Electrical Engineers.

A factory for the electric extraction of zinc has been started at Hoslund, Norway, by Dr. Gustaf de Laval. A consignment of pure zinc has already been exported, and the process is said to work satisfactorily.

The Independent Telephone Association of the United States.

Seventh Annual Convention, Chicago, Ill., June 24 and 25.

THE seventh annual convention of the Independent Telephone Association of the United States was opened at two o'clock, Wednesday afternoon, June 24. While there was not as many in attendance as in some former years, the interest was keen and the attendants were attentive and appreciative. President James M. Thomas read his annual address, reviewing the work of the independent interests, the developments which had taken place, and the parts which conflicting interests had played. With the increased confidence of patrons and support of capital, the independent telephone men were reaching out for better conditions.

Judge Thomas predicted a great increase in the membership next year. As it was from necessity that in former years the independent interests organized for development, so is it necessary for progress that the organization of these interests becomes one of solidarity and strength. The successful litigation carried on by association interests had established the right to manufacture and sell independent apparatus. He emphasized the great growth of independent companies, and voiced the sentiment that in no way should the organization be permitted to become a machine for the promotion of personal or corporate interests.

The main necessity now, however, was to determine the most economical methods of operation and improvement in construction, that investors might secure largest net profits at existing telephone rates. Telephone men could not expect capital unless proper results were shown in every city and state. New conditions are continually arising, which could be solved only by strict business methods, and the investor should be made to feel that with greater development would come more staple investment.

A paper was read by Professor J. C. Kelsey, professor of telephony at Purdue University, La Fayette, Ind., on "The Telephone and the Technical School."

Professor Kelsey spoke of the advantages which a technical course offered to telephone engineers, and the growing need of the telephone manager to be thoroughly equipped for his work.

The president's address was followed by the roll call of the states, and ten-minute reports were made.

The Hon. Hugh Dougherty, of Bluffton, Ind., read the report of the "Committee on Patent Litigation," detailing the accomplishments of this committee, and establishing its eminence as a safeguarding institution.

Secretary J. B. Ware addressed the convention, making a strong plea for a census of independent installations in each state. The value of such a census was indisputable. Statistics should be compiled which would show the absolute strength of independent telephony, and give a short range view of affairs in general.

The constitution was amended so that the membership would embrace all owners, operating engineers and manufacturers of independent equipment.

At seven o'clock Wednesday evening the delegates and visitors were given a tally-ho drive to Sans Souci Park, where an entertainment was held.

At the Thursday session, owing to the absence of Senator C. E. Hull, of Salem, Ill., his paper, on "Advantages of Association," was not read. The paper on "Present and Future," by Frank L. Beam, of Columbus, Ohio, was also withheld because of the absence of the author.

Mr. C. E. Tarte, general manager of the Citizens' Telephone Company, of Grand Rapids, Mich., read an interesting paper on "Telephone Discipline."

Mr. F. A. Demarest, general manager Interstate Telephone and Telegraph Company, Trenton, N. J., read a paper on "Eastern Telephone Development."

Mr. Le Roy Stanton gave an interesting talk on economies of operating telephone exchanges, and brought up a fund of experience showing why this needed special attention.

Preceding the election of officers a resolution was introduced calling for the expulsion of the so-called "Bell-Kellogg" interests. This was, however, laid upon the table.

Mr. J. G. Ihmsen, chairman of the general committee, in a happy speech presented retiring president Judge J. M. Thomas with a valuable timepiece.

Judge Thomas acknowledged the gift with a felicitous reply. He hoped that every important development in independent telephony might be directly reflected in the organization. He thanked the donators, not alone for their valuable gift, but for the valuable support they had given him during his administration.

Mr. H. D. Critchfield, in presenting the nomination for president, spoke of the necessity of all independent telephone men to stand together. He introduced a paper containing a request, signed by one hundred and thirty-six members, that Mr. Hugh Dougherty, of Bluffton, Ind., become president of the association. As Mr. Dougherty had agreed to this, he was declared elected unanimously.

Senator C. W. Cline, of Hazleton, Pa., was elected vice-president, and Mr. Frank T. Jones was elected secretary and treasurer.

The following advisory committee was elected: Professor W. E. Goldsborough, La Fayette, Ind.; H. D. Critchfield, and Thomas Finucane, Rochester, N. Y.; W. E. Doolittle, La Fayette, Ind.; C. E. Tarte, Grand Rapids, Mich.; W. H. Moulton, Minneapolis, Minn.; A. L. Tetu, Louisville, Ky.; and E. E. Clement, Washington. President and secretary members *ex-officio*.

A vote of thanks was tendered to the retiring officers and the various committees.

The convention adjourned to meet in September, 1904, at St. Louis, Mo.

EXHIBITS AND EXHIBITORS.

The following manufacturers were represented, many making exhibits at the Auditorium Hotel:

Eureka Electric Company exhibited a line of telegraph apparatus, central energy boards, etc. This company was represented by J. J. Kusel, D. L. Canman, P. J. Dedriksen, H. J. Kusel, V. H. Messinger.

Crawfordsville Wire Nail Company exhibited telephone and telegraph wires. Represented by R. Schweitzer, H. E. Cobb.

Ohio Valley Glass Company made an exhibit of glass insulators. Represented by H. E. Cobb.

National Carbon Company. Represented by A. V. Wood, M. H. Moffatt.

Standard Underground Cable Company. Represented by F. S. Viele, Pittsburg; J. R. Wiley, sales manager, W. W. Rogers.

Automatic Electric Company. Represented by H. D. Critchfield, J. F. Crook, Sanford Harris, Allen Hussey, A. R. Hussey, W. F. Taylor.

Baker & Company. Represented by J. J. Lowthian.

Illinois Electric Company exhibited

several types of hammer drills. Represented by C. W. Bacon, C. J. Litscher.

C. L. Peirce, Jr., exhibited Peirce polehouses, galvanized brackets, expansion bolts.

A. P. Hopkins & Company. Represented by Millard Hopkins, vice-president.

Lindsey Bros. & Company. Represented by G. L. Lindsey, E. A. Lindsey, J. A. Navarre.

Thomas E. Clark Company wireless telegraph and telephone apparatus. Represented by Gustave Riefstahl, Ackland Stiling, advertising manager.

Gordon Battery Company, manufacturer of Gordon cells. Represented by E. M. Deems, western agent; W. C. Banks.

Frank B. Cook, terminals and projectors. Represented by Frank B. Cook, J. A. Cook, C. E. White.

Chicago Telephone Supply Company. Represented by G. A. Briggs, president; H. Randall, secretary and treasurer; S. A. Duvall. This company made an exhibit of telephone apparatus and central energy switchboards.

Monarch Telephone Company, Monarch telephones. Represented by E. E. Yaxley, J. C. Hubacker.

Fisher Billing Company, Billing machines. Represented by M. B. Locke, manager railroad department.

National Cable Hanger Company.

National Telephone Supply Company, Cleveland. Represented by F. B. Auxer.

Williams-Abbott Electric Company, telephones and parts. Represented by L. Sands.

New Haven Novelty Machine Company, cable splicing devices. Represented by H. J. Minnhinnick, western representative.

W. H. Crumb & Company.

Turner Brass Works. Represented by T. F. Farris, F. S. Binckley, P. Henderson, A. W. Straight.

Sterling Electric Company. Represented by H. T. Doolittle, F. E. Ferotchka, E. Shelby.

Carney Brothers & Company, cedar poles.

Valentine Clark & Company, cedar poles.

North Electric Company. Represented by C. H. North, president; F. F. Sapp, L. G. Bowman.

Francis Beidler & Company, Idaho cedar poles. Represented by W. G. Ranshow.

The Miller Anchor Company. Represented by C. H. Miller, Norwalk, Ohio.

Maltby Lumber Company, Bay City, Mich. Represented by I. A. Maltby.

Electric Appliance Company. Represented by S. A. Dinsmere.

American Electric Fuse Company. Represented by Frank C. Jones.

Kellogg Switchboard and Supply Company. Represented by J. J. Dunmore, F. Dommerque, Kempster B. Miller, R. Manser, R. Henis, S. C. Platt, New York manager, C. P. Platt.

Stromberg-Carlson Telephone Manufacturing Company. Represented by A. Stromberg, C. W. Shafer, E. Shafer, C. W. Stiger, J. J. Nate, F. L. Martin, G. L. Brown, L. H. Jackman, D. M. Crist, W. D. Crist, G. Babcock, G. C. Lewis.

Swedish-American Telephone Company. Represented by G. B. Overshiner, A. V. Overshiner, A. P. Macklin.

American Telephone Company. Represented by J. G. Ihmsen, P. C. Burns, New York.

Farr Telephone Manufacturing Company. Represented by Charles W. Farr.

McDermid Manufacturing Company. Represented by C. L. Burlinghame.

W. M. Talbot, manager of the Havana, Cuba, exchange.

American Carbon Company, St. Louis, Mo. Represented by T. P. Gleason.

W. J. Murdock, Chelsea, Mass.

A Study in Wheel Tires.

A Belgian engineer, M. A. Spilberg, recently contributed a paper to the Society of Belgian Engineers on "The Flanges of Electric Tram Car Wheels." A series of tire sections was shown, some of which were worn in a very peculiar way. The track is composed of grooved rails, and current is supplied by the overhead trolley. The tires are of steel, and capable of changing shape not only by wear, but also by rolling pressure, and some of them show swelled projections beyond the original form. Wheels diagonally placed on the truck seemed to wear into similar shapes, and the gears are also placed diagonally. The author believes that the irregular wear may be caused by an unsymmetrical position of the motors. One pinion was assumed to be above the horizontal centre line and the other below it. The author does not consider the effects produced by the position of the gears. It is a mechanical error to allow a car motor to drive entirely from one end. The pinion naturally climbs up or down the face of the wheel, and one bearing of the motor wears more than the other. This sets the axis of the motor at an angle to the car axles, and throws all stress upon one end of the gear teeth, which wear unevenly in consequence, and an end-thrust is produced upon the axles. Where the wheel base is short, this action will be more accentuated. If gears were doubled, it would not be necessary that they should be even half as wide as at present. The ordinary wide gear now used receives all the stress on one corner, yet does not break. Two gears, each of half the width, would, under such circumstances, be twice as strong as a single gear. The excuse that there was not space for two gears loses its force when these points are considered.

Power Transmission Possibilities in the Southern Appalachians.

The present commercial possibilities in the electrical transmission of power over long distances with small loss, and the opportunities thus offered for the combination of a number of small plants into one of considerable magnitude, serve to direct attention to a number of water powers in the southern states which are now totally ignored.

The popular idea of an available water power is a moderate fall on a stream of considerable size, located within a few yards of a railroad. Like many popular ideas, it is only partly correct. The power which can be obtained at any power site on a stream is the product of the weight of the water passing the site per unit of time multiplied by the height of the perpendicular fall obtainable, and for the same total power these quantities vary inversely; that is, if the head be doubled the quantity of water may be diminished by a half and the resultant power will be the same; if the head be multiplied by ten, then one-tenth the quantity of water will yield the power, and so on, in similar ratio.

Given a sufficient fall, therefore, a small amount of water may be made to furnish a very large amount of power, and in point of fact many of the large power developments of the western states are of this type, the quantity of water used being small, but the head being measured by hundreds of feet. The distance between the points where the power is developed and where it is to be utilized is annihilated by electrical transmission.

A large number of streams in that part of the southern states in which the Appalachian mountain system attains its maximum development have their sources far up on the mountain slopes, in regions of great rainfall and of large and permanent run-off, and these, in their courses to the valleys below, often fall hundreds of feet within short distances. By the application of proper methods these streams are capable of furnishing and transmitting power in considerable quantity at comparatively small cost, certainly in many instances at less cost per unit of power obtained than would be possible on the large trunk streams, and without the attendant risks.

The flow of many of these streams, now unused and indeed ignored, has been measured by the engineers of the United States Geological Survey, and the results have been published in the series of water supply and irrigation papers.—*U. S. Geological Survey.*

The Production of Diamonds in the Electric Furnace.

(From Our Special Correspondent.)

ONE of the great triumphs of the electric furnace is the production of the diamond by artificial means. This has been carried out at the University of Paris, by Professor Henri Moissan, who has become famous for his work in electrochemistry. The electric furnace used in the experiments was designed in order to use the heat of the arc without employing the electrolytic action of the current. The arc is formed just over a carbon crucible which contains the material. The engravings show the furnace complete and in section, also the details of the various parts. Carbonate of lime is used for the body of the furnace. It has two advantages, one that it is quite solid, and another that it can be obtained in nature in large blocks. It very rarely splits under the action of the heat; however, the lower block is reenforced by a sheet-iron box and the cover is surrounded by an iron band. The carbons are about two inches in diameter. The lower block is hollowed out to receive the crucible and also grooved to admit the carbons. The latter are held by a metal clamp at each end, which also receives the heavy cable bringing a current of 800 to 1,000 amperes. The clamps are fixed to a sliding piece which enables the carbons to be adjusted so as to regulate the length of the arc. In the photograph the furnace rests upon a block of chalk which supports it at the proper height.

As the chalk which forms the furnace is easily reduced at a high temperature to form carbide of calcium, a layer of magnesia is placed underneath the crucible to keep it out of contact with the chalk; magnesia is about the only body which is not reduced by carbon, and it thus prevents the formation of carbide. The first crucibles were made of retort carbon turned into cylindrical form on the lathe, but these had the drawback of swelling up when the carbon was transformed into graphite by the action of the heat. At present the crucibles are formed of carbon pressed in a mould, and these keep their form even at a high temperature. The crucibles are about four inches in diameter and three inches high, and can yield 300 or 400 grammes of melted tungsten or uranium in five minutes. The furnace uses a temperature of at least 3,500 degrees centigrade. The cavity is made as small as possible, with a very strong arc, so as to secure a high heat.

After Lavoisier had demonstrated that the diamond was composed of crystallized carbon, numerous attempts were made to produce it artificially, but none of them has been successful up to the present, doubtless because the experiments were not carried out with sufficient method and perseverance. Before taking up the experiments on the diamond, M. Moissan made a careful study of the forms of carbon, graphite, etc., occurring in nature and those produced by the electric furnace. These researches, which are of great interest, can not be dwelt upon at present. It was after this work that he took up the study of the diamond. He concluded that if the diamond could be formed by an artificial process, the first crystals obtained would be extremely small, and even of microscopic size. If the large quartz crystals which occur in nature are compared with those which are obtained by synthesis, by M. Daubreé's method, it is not to be expected that at first diamonds are to be produced which weigh several carats. He

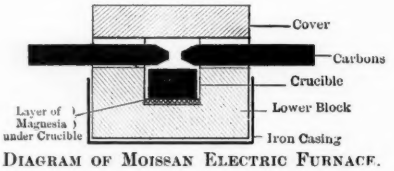


DIAGRAM OF MOISSAN ELECTRIC FURNACE.

therefore conducted the experiments with the greatest care and always used the microscope. The residues of the experiment which were left after the various chemical treatments were sometimes very small, but owing to the use of the microscope he was successful in carrying out the work. The minute crystals had to be separated from a great excess of graphite and other bodies.

The diamond may be defined as a simple body having a maximum hardness, a density of 3.5, and burning in oxygen above 700 degrees centigrade, one gramme yielding 3.666 grammes of carbonic acid gas. To be classed as a diamond, a body must answer to all three of these tests. Boride of carbon and other hard and dense bodies will also burn in oxygen and give carbonic acid gas, and this body and some other new ones formed in the electric furnace are hard enough to scratch the ruby. Again some compounds of titanium have as high a density as the diamond. Therefore to make sure that the newly found crystals were really diamonds, they had to undergo all three tests, and this they accomplished successfully.

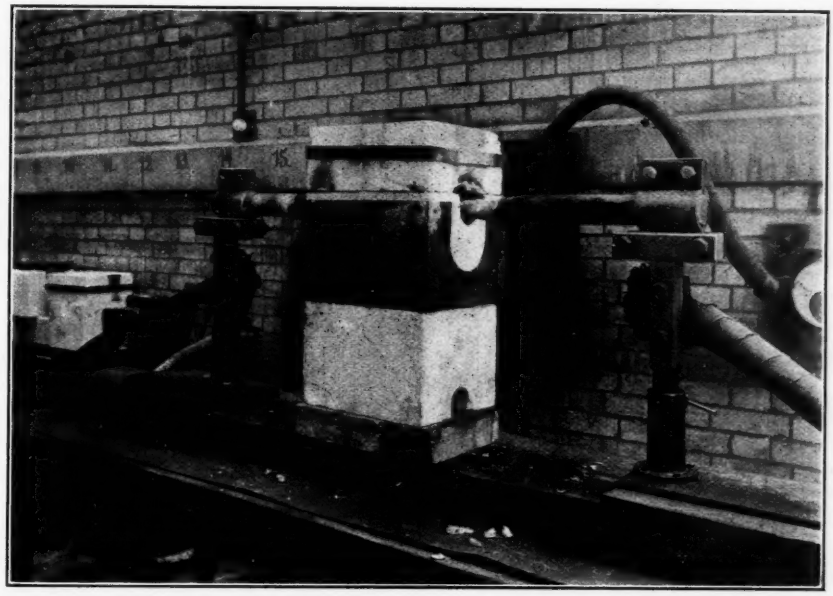
It should be remarked that M. Moissan found microscopic diamonds to exist in nature. On examining the "blue earth" from the Cape he found that it contained microscopic specimens, and while this has no importance from a commercial point of view, it is of great interest here as showing that microscopic diamonds occur in the natural state. After producing the diamonds in the electric furnace, he compared them with the natural specimens and found them quite similar. The diamond-bearing sands of Brazil contain microscopic diamonds, and he also found them in a meteorite from the Diablo Cañon, Arizona, and in other meteorites.

The preceding researches showed that if carbon was produced at low temperatures, from 20 to 200 degrees centigrade, is was always obtained in the amorphous state and no crystals were formed. To obtain the crystals he first tried to separate the carbon from a solvent by a simple variation of temperature. He dissolved carbon in various metals at a high temperature in the electric furnace, but when the metal was dissolved out he obtained nothing but graphite, so another step had to be made. It seems to be proved that in nature the diamond comes from the lower strata of the globe, and has doubtless been produced there; it is probable that great pressures entered into play at the time of its formation. Different facts seem to prove that the diamond has been formed under great pressure. Seeing that the diamond is always found in a detached or isolated state, and often in regular crystals, it seems probable that it has been produced in the midst of a liquid or semi-liquid mass in fusion. The carbon must have been dissolved in some substance and then separated out as a crystal. He found that the best solvents for carbon were the metals in fusion, and especially iron, and therefore tried to separate the carbon in the crystalline form from its solution in iron in fusion, as different facts seemed to show that this might have been the process carried out in nature. A striking fact is shown by the meteoric iron from the Diablo Cañon, which shows, surrounded by compressed layers of amorphous carbon, two small, transparent diamonds, thus seemingly indicating the natural process. The carbon must have been crystallized under the action of a very

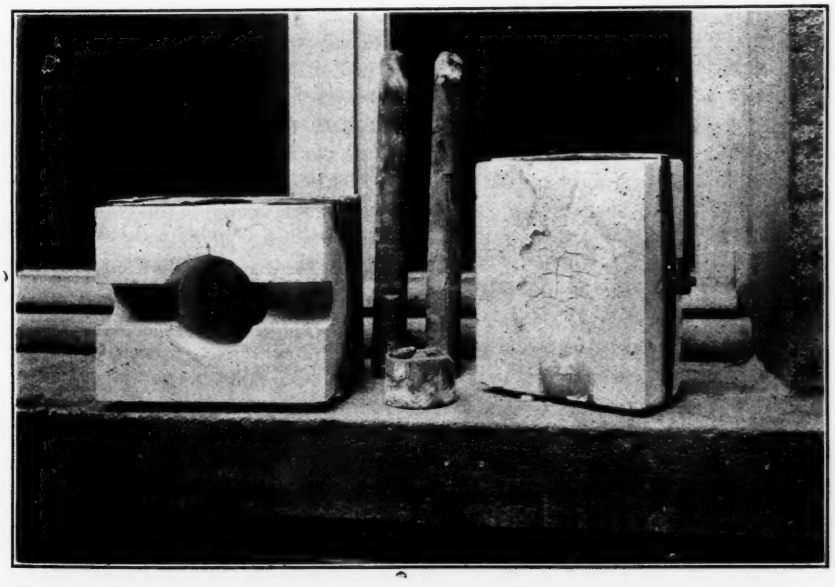
high pressure. The iron was in the liquid state, and owing to its rapid cooling the mass contracted suddenly and with force, and the carbon in solution increased in density from 2 to 3.5, thus producing the diamond. These considerations led directly to the following experiments in which M. Moissan was successful in imitating the natural process by artificial means, and thus produced specimens of the diamond in small crystals.

To realize the experiment, he utilized the pressure which is produced in iron when it passes from the liquid to the solid state. It is known in fact that solid iron is less dense than when in fusion, as is shown by the fact that pieces of the metal will float on the melted bath, and it thus resembles water in this respect. He melts the iron in the electric furnace, which is above described, and saturates it with carbon, and to carry this out, 200 grammes of Swedish iron cut into cylinders one-half inch long and two-fifths inch diameter were placed in a carbon crucible and completely covered with powdered charcoal. The crucible was placed under the arc (as shown in the sectional view) and heated during three to six minutes with a current of 350 amperes at 600 volts. The cover of the furnace was removed and the crucible seized with a pair of tongs and plunged quickly into a bath of cold water. The crucible and metal remain red for a few moments, giving off gases which come to the top, then the whole cools off. It was not without apprehension that the experiment was made for the first time, as it was feared that an explosion would be produced when the melted mass at 3,000 degrees came in contact with the cold water. But no bad effect is produced with iron, although bismuth under the same conditions explodes violently, and shatters everything.

The metallic mass is treated with hydrochloric acid until nothing more is dissolved, when there remain three kinds of carbon; first, graphite; second, a brownish colored carbon in very fine strips, appearing to have undergone a strong pressure like that of the Diablo Cañon meteorite; there remained a very small quantity of a more dense carbon which had to be separated. The two former varieties of carbon were dissolved out by treating with aqua regia and hydrofluoric acid, then by placing the residue in sulphuric acid at 200 degrees centigrade, into which is projected nitrate of potash in powder. After further treatment all the amorphous carbon is destroyed and the denser portions which were examined by the microscope contained no graphite and consisted of different varieties of carbon. By placing in bromoform, which has a density of 2.9, some pieces of high density fell to the bottom and were separated. Then the small residue at the bottom was placed in a tube containing iodide of methylene, a very dense liquid of 3.4. Some small particles deposited and a few black fragments floated on the liquid. All these particles consisted of black and transparent diamonds, which were examined under the microscope. The particles which floated were the opaque or black diamonds, having a rough surface. Their density varies from 3 to 3.5. Some specimens are smooth and have curved lines. The transparent diamonds were next examined. They were of brilliant appearance and had the same general aspect as the natural rough diamond. The surface presented parallel striæ and sometimes triangular impressions. The fragments of clear diamond were very often surrounded by a layer of black carbon, which was difficult to dissolve off. Some of the diamonds had rounded surfaces, while others seemed to be broken into small pieces. One fragment had a yellow color. Other specimens appear as cubes or have an irregular form. Their density is near 3.5, as proved by their sinking in iodide of methylene. They will scratch the ruby without difficulty. These specimens were burned in oxygen and left practically no ash. As only a very small



MOISSAN ELECTRIC FURNACE FOR THE PREPARATION OF THE DIAMOND.



MOISSAN ELECTRIC FURNACE USED IN PREPARING THE DIAMOND, SHOWING LOWER BLOCK HOLLOWED OUT AND ITS IRON CASING, THE TOP COVER, CARBON AND CRUCIBLE.

quantity of the crystals is thus obtained, a second method was used which gave better results.

It seemed that the rapidity of the cooling had a capital influence upon the formation of the crystals. When the mass is cooled in water it becomes surrounded by water vapor which prevents all contact between the hot mass and the liquid; and during the first period the mass is cooled rather by a rapid radiation. In order to cool it by conduction, and thus more quickly, it was placed in iron filings. In this way the diamonds which were obtained were of a peculiar nature, and they contained specks of black carbon. The pressure seems to be less, and the transformation of the carbon into the diamond is less complete. The experiment is, however, highly instructive, as it gives a form of speckled diamond which is also found in nature. To obtain a more rapid cooling, a bath of melted lead was found the best; it was kept at about the fusing point, or 325 degrees centigrade. The crucible, heated as before, is quickly plunged into the bath of melted lead which is about six inches deep. The iron, which is lighter than the melted lead, is detached from the crucible in masses which tend to form spheres and rise more or less rapidly to the top. When the iron is saturated with carbon in the furnace, it becomes so pasty that the crucible can be turned over and it will not run out, but when it cools off, the metal soon becomes liquid and gives up graphite. The smallest spheres, one-half inch in diameter, were solid and sufficiently cool on coming to the top. These spheres gave a good yield of diamonds and the latter were especially clear and brilliant, and the spotted form is absent. Some of the crystalline forms were very sharp. One of the transparent diamonds measured as high as 0.57 millimetre and had a somewhat triangular form with the angles rounded off. It was perfectly clear. It is curious to note that three months after its formation it split into two different pieces; this fact is significant as some diamonds from the Cape show an identical action, this being no doubt due to irregularities of pressure at the time of formation. The samples of diamonds obtained by this method were interesting to examine as to their different forms. Most of them were smooth and brilliant, while others had a grained surface. All the specimens had the particular lustre which is characteristic of the native diamond. When a ray of light is sent into the interior they appear to become luminous. Some of the specimens are cubes and octahedra, with rounded angles.

One of the best experiments was as follows: A cylinder of iron seven inches long and six inches in diameter is turned in the lathe and has bored in it a cylindrical hole of one and one-half inches diameter and five inches deep, into which slides a cylinder which serves as a stopper. The apparatus is placed in a bucket of cold water. The 400 grammes of iron are melted in the electric furnace and saturated with carbon, as before. The mass is flowed into the block and the opening quickly closed by the iron stopper. By the large mass of iron a very rapid cooling is obtained. Then the metal is turned off in the lathe, and the mass of iron in the interior is treated as before to obtain the diamonds. This method gives a superior quality of diamonds to the preceding, although the quantity is not large. Some specimens of diamond were very well crystallized and perfectly transparent; while others were speckled. When a copper block is employed the cooling is still more rapid and the finest quality of diamonds has been obtained by this method, with but few imperfect specimens.

As the yield is now greater it only remained to burn the specimens in oxygen and verify the weight. This was a most difficult process, as the yield is always very small and the separation of the microscopic crystals long and intricate. However, M. Moissan succeeded in obtaining enough of them to burn in oxygen after weighing them carefully. In several experiments the theoretical weight of carbonic acid gas was obtained, which is all that remained to show that the specimens were veritable diamonds.

C. L. DURAND.

Paris, June 13.

Excursion to the General Electric Company's Shops at Schenectady, N. Y.

On Thursday, June 18, by invitation of the General Electric Company, the editors of the technical papers visited the company's shops at Schenectady, to view the Curtis steam turbine in operation and during construction. Mr. E. H. Mullin, representing the company, was in charge of the party, which left New York in the morning in a special car. The trip was thoroughly enjoyable in every way, as no effort had been spared to assure the pleasure and comfort of the guests. After reaching Schenectady, where the party was welcomed by officers of the company, lunch was served in the officers' dining room.

After lunch the party was conducted to the new shop where the turbines are built. Although this is only a temporary building, it is about 800 feet long and ninety feet wide, and already contains a number of interesting tools. A contract was recently made for a much larger building, which it is hoped will be ready for use by the first of the year. The tools were shown at work on various parts of the turbine, the machines for cutting the buckets being particularly interesting. Turbines were seen in all stages of construction. Every tool was at work, and it was evident that the General Electric Company is making every effort to hasten the day when it can begin filling the orders for this new prime mover. It was stated that orders have been received for about a quarter of a million horse-power.

In this shop there was also a 500-kilowatt turbine generator set, under test. The beautiful operation of this set, and its small size compared with the reciprocating type, were very impressive. Except for the hum of the machine and the draft of air produced, an observer would never have suspected that the machine was in operation. The parts for sets having a capacity of from 500 to 5,000 kilowatts were seen in this shop, and here again the contrast between this type of prime mover and the reciprocating type was very striking.

After an instructive and enjoyable hour spent in this shop, the party was shown through the power-house, where one of the first Curtis turbines to be built was seen in actual service. This machine is giving most satisfactory service, and it was stated that after it had been installed it was run continuously for one year without being shut down.

The party then returned to New York in the special car, and during the run was served with a delightful dinner. A hearty vote of thanks was tendered to the General Electric Company and to Mr. Mullin for the trip, which had been most profitable and enjoyable.

The Curtis turbine, the patents for which are owned by the General Electric Company, is one of the latest and most successful types of turbine which have yet been developed. In this turbine steam is partially expanded in a properly designed nozzle, and having thus acquired velocity, it is passed through alternately fixed and movable discs, having carefully designed deflecting buckets. Here it gives up its kinetic energy to the moving discs, and issues at a lower pressure and a comparatively low speed. It then passes through a second set of nozzles and another set of vanes, and so on, through as many stages as seem desirable, to the condenser. The number of fixed and moving discs in each

stage varies according to the pressure and the size of the turbine. As the steam passes through a series of stages, in no one stage does it acquire the high velocity it would have if it were expanded directly from the boiler pressure to that of the condenser, and it is, therefore, possible to run the discs at a lower speed, and still use the steam efficiently.

The nozzles are passages cut or cast in a plate, which in the first stage forms the bottom of the steam chest. In the succeeding stages the nozzles are secured to a diaphragm separating the stages. The nozzles of the first stage occupy a portion only of the circumference and may be grouped together, as in the small sizes, or divided into two or more equal groups. In the succeeding stages the nozzles may occupy the entire circumference.

The nozzles are designed to maintain a certain pressure relation between the two stages. The steam leaving one set of nozzles is at a pressure slightly above that at the next set, and expands down to the lower pressure during its passage through the rings. Thus a turbine may be designed to run condensing, but by throwing the last stage out of operation it can be run non-condensing, the last stage being designed to expand the steam from atmospheric pressure down to that of the condenser.

Governing is effected by the opening or closing poppet valves in the steam chest, thereby allowing steam to pass through one or more of the expanding nozzles. There is thus always a constant flow of steam, when under load, through one or more of the nozzles, thus providing a constant turning effort; and the variations in load are taken care of by opening and closing the valves to other nozzles, as may be necessary. To avoid leakage, the clearance between the moving and stationary vanes is small, this calling for good machine work and careful adjustment.

The type of unit adopted is somewhat similar to the vertical water-driven turbine generator set. The axle is vertical. Steam enters in the steam chest, passing down through the expanding nozzles to the moving and stationary blades through the various stages, and into the exhaust chamber below. The generator is placed above the turbine, and is of the revolving internal field type. The weight of the moving parts is supported in a bearing supplied with oil under pressure. The appearance of the turbine is very pleasing and the observer is impressed with the substantial construction and the small floor space required.

Tests which have been made at the shops show that the turbine is highly efficient and that its efficiency remains very constant throughout a wide range of load. Tests of a 500-kilowatt unit gave a steam consumption of about 16.25 pounds per kilowatt-hour, with a steam pressure of 200 pounds per square inch, a vacuum of 28.5 inches and with 150 degrees Fahrenheit. The turbine was running at 1,500 revolutions per minute. It is stated that variation of efficiency of the 5,000-kilowatt unit will not be more than three per cent from half load to fifty per cent overload. This machine is expected to give considerably better performance than the figure quoted for the 500-kilowatt turbine.

The Faraday Society.

The Faraday Society was organized recently in England to promote the study of electrochemistry, electrometallurgy, chemical physics, metallography and kindred subjects, and has issued a pamphlet giving the rules of the organization. The society will consist of members and students. Members must be persons over twenty-one years of age. Students are persons who at the time of election are following scientific or technical courses at recognized institutions. No person shall remain in the student class for more than three years, unless he is not twenty-one years of age by the end of that time. Students may not vote. Persons who have applied for admission to the society before July 1, 1903, shall be elected by the council. Candidates who apply for election after that time must be proposed and seconded by members of the society. The dues are £2 ($10) for each member, and £1 ($5) for each student, per year. The entrance fee is £1 ($5), no fee being required of students, nor at the transfer of a student to the member class.

The society will be governed by a council consisting of the president, the five junior past-presidents, seven vice-presidents, the treasurer and ten ordinary members. The president shall hold office for one year, and may not be elected for more than two consecutive years. Two vice-presidents and three ordinary members of the council shall retire from office each year, and no vice-president or ordinary member of the council shall hold office for more than three years. The method of retiring the odd vice-president is not explained. The secretary and treasurer are elected annually, and are eligible for re-election.

Ordinary meetings will be held from time to time, and there will be an annual general meeting each year. The proceedings of the society will be published in the *Electrochemist and Metallurgist*, issued monthly, free to members.

The first ordinary meeting will be held on June 30, at which a number of papers will be read.

Applications for membership should be sent to Mr. F. S. Spiers, 82 Victoria street, London, S. W. Checks and postal orders should be made payable to the treasurer, Dr. F. Mollwo Perkin, and crossed "London & County Banking Company, Limited."

CORRESPONDENCE.

Siloxicon.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

The descriptions of the new refractory substance, siloxicon, that have recently appeared in the newspapers have created such a widespread interest, as evidenced by the numerous enquiries received from all parts of the country and all lines of industry, that it is desirable to correct a statement that was contained in these publications.

It was there stated that siloxicon was inoxidizable, but recent investigations have shown that this is not true. When it is heated to, or above, 2,674 degrees Fahrenheit in an atmosphere containing a large amount of free oxygen decomposition occurs.

Siloxicon, while variable in composition, may be represented by the formula Si_2C_2O, and when heated, as above stated, in presence of free oxygen, decomposition takes place, probably in accordance with the following equation:

$$Si_2C_2O + 7O = 2SiO_2 + 2CO_2.$$

If the siloxicon be in the form of a brick or other moulded mass the reaction occurs on the surface, producing a vitreous glaze which in most instances is tinged light green from the presence of iron.

In the absence of free oxygen or in a reducing atmosphere no such decomposition occurs, and the temperature may be raised to the point of the formation of carborundum, or, approximately, 5,000 degrees Fahrenheit, before any change occurs, and then it takes place, it is thought, in accordance with this equation:

$$Si_2C_2O = SiC + Si + CO.$$

solid carborundum remaining, while the vapor of silicon and carbon monoxide are given off.

It is interesting to note that after having discovered this oxidation of siloxicon, tests were made with carborundum and it was found to be affected in a manner exactly similar to siloxicon; this, notwithstanding the fact that for more than twelve years it had been generally considered inoxidizable.

EDWARD G. ACHESON.

Niagara Falls, June 18.

TRANSMISSION COMMITTEE.

INTRODUCTIONS TO DISCUSSION, TO TAKE PLACE AT THE INSTITUTE MEETING, NIAGARA FALLS, JULY 1.

The following papers are introductions to a discussion to take place at the Institute meeting at Niagara Falls on July 1. They are not intended to be formal or complete papers, but serve merely as a basis or framework for discussion on the subjects with which they deal.

THE GROUNDED WIRE AS A PROTECTION AGAINST LIGHTNING.

BY RALPH D. MERSHON.

Some of the transmission lines of this country have installed upon them as a protection against lightning one or more wires strung parallel to the power wires and grounded at intervals. There is a difference of opinion among those operating such lines in different parts of the country as to the efficacy of this device. The importance of the subject makes it desirable to have an expression of opinion upon it from those members of the Institute who have had experience in operating such lines or who have given the matter close consideration. This can perhaps be best arrived at by a discussion on the subject.

THEORY.

There are three ways in which lightning can affect a transmission line; by a direct stroke, by electromagnetic induction and by electrostatic induction. Protection against the first of these would be almost impossible, certainly impracticable. Fortunately, lines are not often struck by lightning. The second, electromagnetic induction, is, in the opinion of the writer, a theoretical possibility—nothing more. It is against the effects of the third, electrostatic induction, that lines are to be protected, whether by lightning arresters or by grounded wires.

The theory of the electrostatic induction action may be explained with practical accuracy as follows: The whole transmission system, line, transformers, etc., may be regarded as an electrostatic conductor, insulated from the earth. Suppose a cloud heavily charged with, say, a positive charge, to move up to the region over the transmission line. There will be a positive charge "set free" on the transmission system and it will have a tendency to pass to earth. It will pass to earth by gradual leakage over and through the insulation of the system if the approach of the cloud is slow enough to give time for such leakage; if not, it may puncture the insulation and thus pass to earth. The intensity of the charge will depend upon the potential at the line wires due to the charge of the cloud. Suppose there be near the transmission wires other wires parallel to them and grounded at frequent intervals. They will also be subject to the inductive action and the charge set free upon them will pass to earth as fast as liberated, the "bound" charge of the opposite sign of that of the cloud remaining and depending for its magnitude on the potential due to the cloud and the electrostatic capacity of the grounded wires. Under these conditions the intensity of the charge on the transmission wires will no longer depend only upon the potential at them due to the cloud, but upon the combined action of the charge of the cloud and the bound charge of the grounded wires. In other words, the potential of the line wires will be equal to the difference of the potentials due respectively to the cloud and the grounded wires and will in general be less than that due to the cloud. This action constitutes what may be designated as the "shielding action" of the grounded wires.

Return now to the condition where, with no grounded wires, the system has been gradually charged and the charge has gradually leaked away, leaving a bound charge of negative sign on the system. Suppose now the cloud be discharged by a lightning flash to earth. The potential due to it at the transmission wires is now zero and there is consequently left upon the transmission system the negative charge which was previously "bound" but is now "free" and which has a tendency to pass to earth and will probably do so suddenly. Its passage to the earth may mean a puncture to the insulation of the system. If, however, we assume that the grounded wires are again present and the charge bound on them by the cloud and set free upon them by the lightning flash can readily pass to earth, there will be less tendency toward the puncture of the insulation of the system because of the fact that, as previously explained, the impressed potential of the line wires before the flash is less with the grounded wires than without them. If the charge on the grounded wires can not pass readily to earth the charge on them will tend to set free a negative charge on the line wires, which will be added to that set free on the line wires by the lightning flash. The worst condition would be that under which the charge on the grounded wires could not pass to the ground at all, in which case the sum of the two charges on the line wires will be just equal to that which would have existed if there were no ground wires. The passage of the charge from the grounded wire to ground will always be more or less obstructed by the inductance of the discharge path, the effectiveness of this inductive obstruction depending upon the suddenness with which the cloud discharges. This inductive action of the ground wires due to the charge left upon them we will designate as the "direct action" of the wires.

The "shielding action" of the ground wires may be calculated by making assumptions which will approximate to a degree those which obtain in practice, but the calculation of the "direct action" is less satisfactory since it involves a number of assumptions, all more or less speculative in their nature. This is due among other things to the fact that we can not know how long the lightning flash will last or whether it will be oscillatory or not. Furthermore, we do not know what the dielectric strength of the insulation of the system will be for periods of time so short as those involved under the conditions mentioned. We do know, however, that under the worst conditions that can obtain the insulation stress due to the "direct action" of the grounded wires can be no greater than though they were not present and will in general be less. We also know that whatever be the maximum value of this insulation stress it will diminish rapidly either in an oscillatory or non-oscillatory manner, the rapidity of the diminution depending upon the freedom of the discharge path from obstruction. It is to be noted that the time-element of dielectric strength is not involved in the calculation of the "shielding action" to the degree that it is in the "direct action;" since in the former case the charge comes on to the system more or less gradually and we may assume without great error that ordinary values of dielectric strength hold.

In order to get an idea as to the magnitude of the "shielding action" let us calculate its effect under the most simple conditions. Suppose we have two No. 00 wires stretched side by side on a pole line 20,000 feet in length, the wires being one foot apart. Call these wires A and B. Suppose first that both wires are insulated from ground and that the space occupied by them is raised by the inductive action of a cloud to a potential V above the earth. The expression for the potential of a long cylinder or wire of length l and diameter d, having upon it a charge whose density is δ is

$$v_1 = 2\pi d\,\delta \log_e \frac{2l}{d}$$

The potential outside such a wire at a distance s from its axis is

$$v_2 = 2\pi d\,\delta \log_e \frac{l}{s}$$

Each of the wires A and B has upon it, therefore, a free charge of such a density that

$$V = 2\pi d\,\delta \log_e \frac{2l}{d} \quad \therefore \delta = \frac{V}{2\pi d \log_e 2l/d}$$

Now let one of the wires A be connected to earth. The free charge on A goes to earth, leaving a "bound" charge whose density is equal and opposite to that of the free charge or

$$-\delta = \frac{V}{2\pi d \log_e 2l/d}$$

The potential of any point distance s from the wire A and due to the bound charge of density $-\delta$ is, therefore,

$$V_1 = -2\pi d\,\delta \log_e \frac{l}{s} = -\frac{V \log_e l/s}{\log_e 2l/d}$$

The resulting potential therefore at any point distant s from the axis of the wire A due to the combined actions of the charge on the cloud and the bound charge on A is

$$V + V_1 = V\left[1 - \frac{\log l/s}{\log 2l/d}\right] = V\left[1 - \frac{\log l - \log s}{\log 2l - \log d}\right]$$

This expression will give the resultant potential at the wire B when A is grounded, if we substitute in it the value $l = 20{,}000$, $d = 0.3648$ inch $= 0.0304$ foot = diameter of No. 00 wire and $s =$ 1 foot. Substituting these values we have

$$V + V_1 = 0.29\text{?}\ V$$

It appears therefore from this rough calculation that if each wire of a transmission line 20,000 feet in length, the conductors of which consist of No. 00 wire, have stretched parallel to it and at a distance of twelve inches, a grounded wire equal in size to the line wire, the potential of the line wire due to a charged cloud could not rise to exceed thirty per cent of the value to which it would rise if the grounded wire were not present. As a matter of fact, if each of the line wires had its corresponding ground wire the potential to which they could rise would be even less than this because each line wire would be influenced not only by its own grounded wire but by all of the other grounded wires also. However, it is not usually the practice to employ a grounded wire so large as that assumed, and twelve inches is a smaller distance from grounded wire to line wire than would usually have place. The usual variation from these quantities will about compensate for the effect due to a greater number of grounded wires as usually arranged, so that the example taken serves its purpose as furnishing a criterion as to the magnitude of the effect of the grounded wires. It does not and is not intended to furnish a criterion as to construction or practical details.

MATERIAL AND DIMENSIONS OF GROUND WIRES.

Ground wires are usually of galvanized iron. This material is probably as good from an electrical standpoint as any other, since with the rapid flow which must take place at discharge the material of the wire itself will probably make little difference in the obstruction offered to the flow. The size of the wire will have an important bearing since in general the larger the wire the less obstruction it will offer and also the greater its "shielding action." Greater effectiveness will be obtained of course for given amount of material from a number of grounded wires of smaller size than from a smaller number of larger size. Barbed wire is often used for grounded wires, but in the opinion of the writer it has no advantage over smooth wire. It seems to have been adopted with the idea that the points would in some way discharge the atmosphere, but if the accumulation of a charge on the line wires is in accordance with the explanation already given the points can not be effective in any way.

METHOD OF INSTALLATION.

Usually three grounded wires are installed, one on top of the pole and one on each end of a cross-arm. They are generally tied to glass insulators presumably for mechanical reasons, as all three wires are of course grounded. The wires should be grounded as often as possible, so that the obstruction to the flow between grounded wire and earth shall be kept as low as possible, thus keeping down the direct action of the grounded wire to as low a figure as possible.

RESULTS IN PRACTICE.

The writer has known of a number of plants where grounded wires were installed. In one of these, as the result of a number of years of operation, those in charge of the plant feel sure that the grounded wires furnish a reliable and effective protection against lightning. In some of the other plants those operating think that the grounded wires furnish more or less protection but are doubtful as to the amount. In still other plants those in charge feel sure that the grounded wires are of no value whatsoever and constitute a nuisance and menace because of their liability to break and fall across the power wires. In some of the cases of doubtful success or failure the trouble may have been due to poor grounds or to the wires not having been grounded frequently enough, as in some of these cases the wires were not grounded at every pole. In all of the doubtful cases lightning arresters which were installed in addition to the grounded wires received more or less discharges during thunder-storms.

THE OPERATION AND MAINTENANCE OF HIGH-TENSION UNDERGROUND SYSTEMS.

BY PHILIP TORCHIO.

The following notes apply mainly to moderately high-tension systems as installed in large cities in the last few years:

(1) INDEPENDENT VS. PARALLEL OPERATION OF FEEDERS AT SUBSTATIONS.

By proper selection of size of feeders and transforming units at substations, each feeder can be operated to supply normally an independent group of transforming apparatus. In case of emergency the same apparatus can be arranged to be fed from other feeders through an emergency bus. This arrangement of independent operation of feeders has in most cases the disadvantage of not allowing the full use of the copper investment at light loads, but it has the following advantages:

(*a*) The short-circuit current fed back from the substation bus-bars into a faulty feeder is limited by the reactance of at least two sets of transforming apparatus. This will materially help the final clearing of the short-circuit.

(*b*) In rotary converter substations the independent groups of transforming apparatus can be fed from different bus-bars or from different generating stations, thereby increasing the reliability of service.

(2) TESTING OF CABLES.

(*a*) Periodic insulation tests are valuable as they furnish indications of abnormal conditions and often lead to the detection of faults on the systems. The instruments usually used in connection with insulation tests are a D'Arsonval galvanometer with shunt, and a battery of

from 70 to 100 volts. Periodic tests should be made at least once a week on each feeder, and oftener under abnormal conditions.

(*b*) High-voltage tests of dielectric strength of insulation should be carefully applied or possibly avoided entirely. Experience has demonstrated that failure of cable feeders are almost uniformly due to defective joints or mechanical injury to the cable. The record of all high-tension cable faults of a New York company for a period of five years is as follows:

LOCATION OF FAULTS ON HIGH-TENSION CABLES.

Manifested by Opening of Circuit-Breakers During Operation.	Manifested by Low Insulation Test.	Reported by Line Inspectors.
1 In splice.	1 in splice.	1 injured in manhole by arc cable burnout.
1 nail driven into cable (external mechanical injury).	1 in splice.	
1 in sharp bend in manhole.	1 in splice.	1 damaged in manhole by alternating-current lighting cables burnout.
1 in damaged sleeve (external mechanical injury—cause unknown).	1 leak of steam to cable end.	
1 in bend in small manhole.		1 damaged by outside parties doing subway work.
1 wet end of cable (external injury due to water leak).		1 damaged as above.
1 wet end cup caused by stean (external mechanical injury).		1 damaged as above.
1 steam in substation (external mechanical injury).		
1 in splice.		
9	4	5

Note that of the nine faults manifested during operation, five were due to extraneous mechanical causes and four to defective installation.

The operating voltage of this system is 6,600 volts.

The lengths of high-tension cables in operation on December 31 of the first and last year covered by the record were 3.2 and 84.6 miles, respectively. The cables of this company have not been subjected to high-pressure test in subways.

This table shows that only four cable breakdowns out of eighteen faults on high-tension cables could possibly have been prevented by having originally applied high-pressure tests to the cables. It can not be determined how successful such tests would have been in other respects, as the testing strains might possibly have lowered the dielectric strength of the insulation at points otherwise perfectly safe for operating at the normal pressure. Note must also be taken of the fact that no failure of the cable proper has yet been recorded in this large system, now operating over eighty-five miles of high-tension cables.

(3) INDICATORS AND PROTECTING DEVICES.

(*a*) Ground detectors with annunciator relay and drop-signal are desirable features of a high-tension switchboard equipment. The diagram (Fig. 1) shows an arrangement for a three-phase installation.

(*b*) Grounding of the neutral of high-tension generators is advocated by many engineers, and apparently it has given satisfaction wherever it has been tried. The objection to the heavy short-circuit current from one leg to ground has been overcome by the suggestion of grounding through a non-inductive resistance, thereby limiting the short-circuit current to a predetermined amount. The experience of the companies so operating will be of great value.

(*c*) Spark Arresters—It seems impossible always to guard against the appearance of high voltages due to sudden change of load, grounds, short-circuits, etc., and, especially in the latter case, spark-arresters will greatly increase the safety. These devices are preferably connected delta on systems without grounded neutral and installed at the generator end as well as substation end of every cable and at every other place where the cable is looped into a substation or joins an overhead line.

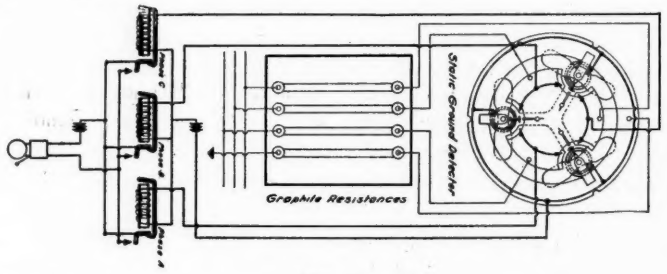


FIG. 1.

(4) APPARATUS AND METHODS FOR CARE OF CABLES.

A new cable should not be connected to the main bus-bars without being previously tested with full working pressure. This is sometimes accomplished through a suitable transformer properly fused or by inverting a rotary converter with a fuse on the low-tension side.

A defective feeder often requires the application of high voltage for breaking down the defective insulation and creating a low-resistance path for sending through it a direct current for the purpose of locating the fault by the compass method applied to the cable in successive manholes. To break down the insulation and char the same it requires about two amperes for paper and five amperes for rubber-insulated cables, applied for about five minutes. The regulation of the amperage could very conveniently be obtained by the use of a reactive coil, or, what amounts to the same, a transformer of sufficient internal reactance to limit the current on short-circuit. But while there may not be much danger of resonance phenomena when using reactive coils, still there is some danger and it is, therefore, safer to limit the short-circuit current by resistance. Fig. 2 shows the connections of a rheostat intended to limit the short-circuit current to two and one-half and five amperes at 6,600 volts.

(5) RULES.

In a large system it is important to devise a set of rules for the guidance of the men in the different departments. These rules must be rigidly complied with so as positively to eliminate any danger to men making tests or repairs to cables or switchboards.

(6) MAINTENANCE.

It is not feasible to estimate accurately the life of high-tension cables and what will be the cost of maintenance after several years' installation. The cost of repairs for the first years is merely nominal, and the only other items of maintenance are the expenses for the periodic inspection and testing and minor details.

ELECTRIC CABLES FOR HIGH-VOLTAGE SERVICE.

BY HENRY W. FISHER.

In the early part of the last decade there was a general belief among electrical engineers that rubber-covered cables would be used almost exclusively for high-voltage service and paper-insulated cables for comparatively low voltages. With the improved manufacture of the latter, opinions have changed so that some engineers prefer paper to rubber, stating that in their experience the life of paper cables is longer than that of rubber cables. To account for this, they believe that the strain caused by very high voltages gradually deteriorates the rubber by some kind of electrolytic action, or by a purely physical action, or by a tendency for static discharges gradu-

ally to penetrate farther and farther until a breakdown occurs. In substantiation of their claims they give instances where rubber cables have broken down one after another in service without any apparent cause. On the other hand, there are engineers who claim that they have operated rubber cables at high voltages continuously without any trouble. The ability of a rubber-insulated cable to withstand high voltages depends upon the ingredients entering into the composition of the rubber compound. The dielectric strength to resist electric pressure becomes greater within certain limits with increased percentages of pure Para or other high-grade rubber; and there is good reason for believing that when lead-covered cables are employed, the life of rubber-insulated cables is lengthened with increased percentages of such rubber. This subject should naturally be treated under three headings:

First—Manufacture of cables.

Second—Installation of cables.

Third—Operation of cables.

1. Manufacture of Cables—In the manufacture of paper-insulated cables for high voltages, great care has to be exercised in selecting the right kind and quality of material, and also in the methods of construction and impregnation of the paper with insulating compound. The most experienced engineers now realize that cables saturated with oily compound can better be handled without injury to the dielectric, and also resist better high voltages. The use of oily compounds is, however, accompanied with lower insulation resistances, and consequently many engineers who think they are adopting the best practice by specifying several hundred megohms per mile, are in reality inviting bids on an undesirable type of cable. The best cables either with paper or rubber insulation should be able to resist comparatively high voltages for an extremely short period of time. Such voltages are obtained at the time of making or breaking the circuit, or during short-circuits. To illustrate; if a cable of inferior material and construction be subjected to a gradually increasing voltage till a breakdown occurs, and then after removing the burnout part the operation be repeated, a second breakdown will almost invariably occur at much lower voltage than at first, showing that the cable was injured by an impulsive rise of voltage at the time of the first burnout. With the best cables the difference between successive voltages applied as above is much less than is the case with inferior cables, and at the same time the former withstand very much greater voltages for the same thickness of insulation. If the question of expense is not a consideration, paper-insulated cable can be made of remarkable dielectric strength. On one occasion the writer designed such a cable with a thickness of insulation capable of ordinarily withstanding 16,000 volts. Extraordinary care was exercised in the manufacture of this cable, and when tested 48,000 volts were required to break it down, and during successive tests the voltages applied scarcely varied 1,000 volts from the above figure, showing a very great uniformity. Such a cable would have a greater dielectric strength than that of ordinary rubber cables, and at least equal to that of rubber cables with high percentages of Para, and would cost fully as much as the latter.

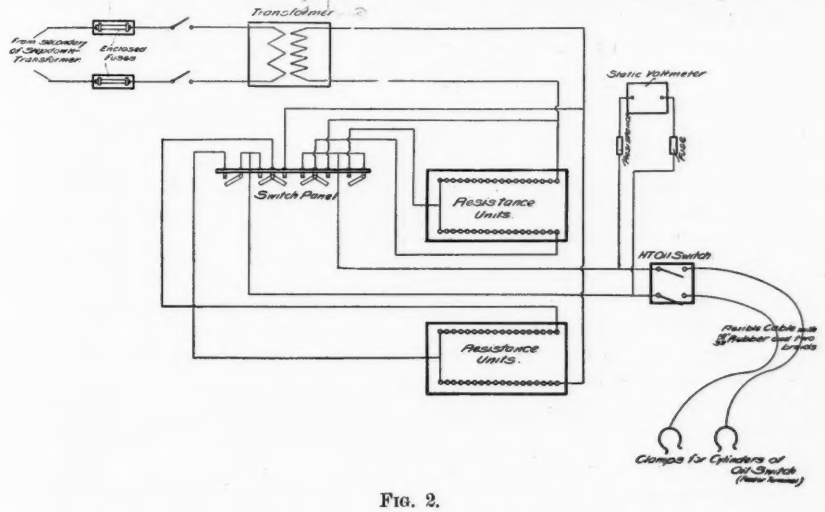


FIG. 2.

In the manufacture of rubber cables, care has to be used in selecting the best and proper materials; and the work of mixing them and masticating and applying the rubber must be done uniformly well, and the process of vulcanization must be carried on at the right temperature and for the right length of time to suit the particular compounds. After being made, all high-voltage cables should be subjected to the usual test for insulation resistance and electrostatic capacity, and also to voltage tests of double the normal working electromotive force. Even if this test is not specified the manufacturer should apply it for his own protection.

2. Installation of Cables—This work must be done by well-trained men, as a small amount of carelessness may mean much trouble and expense. When the cables are pulled into ducts great care must be exercised to prevent abrasion of the lead cover, and no sharp bends must be made because in so doing the insulation may become injured or cracked. It is advisable not to pull paper-insulated cables into ducts during extremely cold weather, because of the possibility of cracking the insulation. If such work of installation has to be done, the reels of cable should be kept in a warm place over night, or else put under a tent for a few hours and kept warm with plumber's furnaces placed so as not to overheat the cable at any point.

The work of jointing the cables must be done by good jointers, who are in turn carefully watched by an experienced foreman. Different companies make different forms of joints, but after a reliable one is adopted the work should be systematic and according to definite directions in all particulars. By so doing, remarkable records of perfect workmanship have been made. After complete installation each cable should be subjected to double the working voltage, but this voltage should not be applied or broken suddenly because by so doing unnecessary strains would be imposed upon the cable.

3. Operation of High-Voltage Cables—This is a subject that could better be presented by the operator of the electric light and power plants where cables are employed. However, as one of the objects of this short paper is to invite discussion, it may be well to state that a perfect protective device for cables and auxiliary apparatus would lessen to a very large extent the troubles of the operator incident to impulsive rises of voltage from switching and short-circuit. On several occasions and in different power-houses, discharges have been seen to take place over the surface of switchboards at the time of short-circuits in cables, transformers, switches, etc. On some of these occasions the rise in voltage necessary to make said discharges was estimated to be about four times the normal working voltage. At such times the original cause of the trouble can not always be ascertained because frequently cables are burned out in several places, and transformers and apparatus injured at the same time. This kind of phenomena seems to be more prevalent and dangerous where air-lines connect with cables. It will therefore be seen that an efficient device which would protect

cables and accessory apparatus from such excessive rises of voltage would be of incredible value to operators.

The question of the carrying capacity of cables is often not considered as carefully as it should be. When a great many cables all carrying normal currents are in one duct-system, the middle and top ones are apt to become very warm. The difference between the temperature of the conductor and that of the duct may be nearly as great as the difference between the temperature of the duct and that of the surrounding air, although generally speaking the former is the least. The carrying capacity of cables, as frequently recommended, is entirely too great when many cables are in the same duct-system.

There is a very great difference in the radiating power of dry and wet ducts, and in the heat conductivity of different soils, and so it is impossible to give set rules governing all cases. Under no circumstances should the temperature of the conductor be allowed to reach ninety degrees centigrade; and if twice the maximum difference of temperature between any duct and earth added to the temperature of the earth is nearly equal to ninety degrees there is reason for apprehension.

THE USE OF AUTOMATIC MEANS FOR DISCONNECTING DISABLED APPARATUS.

BY HENRY G. STOTT.

This subject may preferably be divided into three sections, as follows:

(*a*) Generating apparatus.

(*b*) Transmission apparatus.

(*c*) Receiving apparatus.

(*a*) Generating Apparatus—That no overload device should be used in the generating plant to disconnect disabled apparatus, may be stated as a general proposition.

Experience has probably been responsible for the evolution of the art to a point where it has become not only possible, but necessary to eliminate all overload devices.

Only a brief statement of the reasons for abandoning the use of overload apparatus will be necessary.

In case of an accident to one generating unit, the other units in multiple with it will immediately begin to force current into the disabled one, and the increased load on the good units, due to their normal load plus the short-circuit current supplied to the crippled unit will, in all probability, trip all the circuit-breakers simultaneously, thus interrupting the service.

Without automatic circuit-breakers the overload on the good units would cause the potential of the system to fall so low that the service would, in all probability, be as completely interrupted as in the former case unless the attendant succeeds in locating and disconnecting the crippled unit immediately. Should he fail to do so, the service will inevitably be interrupted, and a great deal of damage done to the crippled unit by the current from the good machines.

It is then evidently necessary to have some means of discriminating between a current coming out of the machine and one going into it. Modern apparatus can safely carry 200 per cent or more load for a few minutes, but if a unit has become crippled it will immediately cease to be a generator and become a receiver. All that is necessary to do then is to install on each generator a suitable circuit-breaker which will operate only when the direction of flow or energy through it is reversed.

This type of safety device has been developed for both direct-current and alternating-current apparatus so that it operates quite satisfactorily.

As an additional precaution in large plants, a second reverse-current relay should be installed which will merely light up a letter or number in front of the operator so that in the event of the failure of the first automatic device the faulty machine may be quickly disconnected by hand. These reverse-current relays should have a time-element and current-limit attachment, which should be set for not less than three seconds, so that a slight reverse current, or one of momentary duration, such as is liable to occur at the moment of multiplying, will not operate the circuit-breaker.

(*b*) Transmission—When transmitting power through overhead and underground cables, it is essential to successful operation to be able automatically to disconnect the feeders from (1) the generating station, and (2) if there are duplicate transmission lines, from the receiving station.

(1) At the generating station this should obviously be done by an overload circuit-breaker, whose operation is delayed by a time-element which may be set at from one to ten seconds according to the local conditions.

This is all the protection necessary or desirable where only one transmission line exists.

(2) With two or more transmission lines in multiple, an entirely different set of conditions exist as in case trouble develops in one, current will be fed back from the receiver end into the fault through the good feeders; the result will be that all the feeder overload breakers at the generating station will trip thus shutting down the entire line and, in all probability, shutting down all synchronous receivers on the system, due to the resultant fall in potential.

Reverse-current relays at the receiver end of the feeders operates satisfactorily, provided the fault is not severe enough to drop the potential.

If, however, the fault amounts to a short-circuit the potential at the receiver end will fall so low that the potential coil of the differentially-wound relay will not receive enough current to enable the relay to operate.

Reverse-current relays on the receiving end of feeders are not as yet to be depended upon, but recent improvements give promise that we may soon expect to find a satisfactory solution of this important problem.

When only two feeders are in use a method devised by Mr. L. Andrews, of England, seems to be very satisfactory. At the receiver end the two feeders are connected together through a choking-coil wound entirely in one direction. The current is drawn from a tap in the centre of this winding. Under normal conditions the feeders supply equal current through each half of the winding to the tap, but as the currents pass in reverse direction through the winding the resultant flux is *nil* and, therefore, the resultant inductance is *nil*, the only loss being that due to the ohmic resistance of the coils.

Should a short-circuit occur in one of the lines, the current from the other line will flow through both halves of the reactive coil in the same direction, thus producing a strong choking effect and limiting the current to an inconsiderable amount.

As the overload circuit-breaker on the faulty feeder at the generating station will trip immediately, it is then only necessary for the attendant at the receiving station to open-circuit the section of the reactive coil connected to the faulty cable and short-circuit the other half connected to the good cable. This device, I am informed, has given excellent results in England, but for obvious reasons would not be suitable for more than two feeders.

Where possible, the safest plan at present is, in the writer's opinion, to run the feeders entirely separate at the receiving end, only putting the direct-current end of the rotaries in multiple; or in cases where low-tension alternating current (2,000 volts or less) is supplied, putting the secondaries in multiple. If, under these conditions, reverse-current relays are installed at the receiving end of the feeders they will operate very satisfactorily, as the reactance of the rotaries and transformers will be sufficient to limit the reverse current in the faulty cable, thus allowing the reverse-current relays to operate as there has been no serious fall of potential.

The greater the number of feeders used between the generating station and the substation the better this method becomes, as, for instance, with two cables a fault in one will only reduce the capacity fifty per cent until the operator can synchronize all the apparatus, which was running on the faulty cable, and as the apparatus and converters will continue to run at full speed only a few minutes will be necessary to synchronize on the good feeder, which will in the meantime carry the whole load, so that no interruption to service will occur. With three cables this would mean a loss of capacity of 33.3 per cent, and with four cables twenty-five per cent, etc.

(*c*) Receiving Apparatus—This should be treated in exactly the same way as the generating apparatus, namely, use reverse-current relays only to operate the circuit-breakers on the rotaries, etc., and use time-element overload relays only on the low-tension feeders leaving the substation.

The above remarks apply generally to both direct-current and alternating-current apparatus, with the exception of the part devoted to transmission apparatus, which, of course, only applies to alternating-current transmission.

The Telephone Exchange of the Manhattan Railway Company.

THE Manhattan Railway Company, New York city, has recently completed a private telephone exchange for intercommunication between its numerous stations, yards and terminals. This installation consists of a complete central energy equipment, and is used exclusively for the business of the Manhattan Railway Company, there being no outside connections. The circuits between the stations and the central office are carried in lead-covered cables suspended from the structure. The longest circuit is about nine and one-half miles, and the conducting cable runs from 5 to 120 pair. Underground cables run across the city through Fifty-third street from Third to Sixth avenues, and through 110th street from Third to Ninth avenues. At the Manhattan drawbridge, where the company's railroad service crosses the Harlem River, the conductors are carried in submarine cables. The entire installation was designed by Mr. W. H. Kinlock, who is the manager of the exchange. The switchboard equipment and power plant were installed by the Lambert Schmidt Telephone Manufacturing Company, New York city, under the direction of Mr. W. T. Booth.

The exchange is located on the second floor of one of the company's buildings at Ninety-ninth street and Third avenue. This point is used as a terminal and repair yard for a portion of the elevated system, and adjoins one of the company's substations.

Fig. 1 shows the switchboard, which is of the common battery, double supervisory, multiple type, and which is equipped with six operators' positions. The ultimate capacity of the board is 600 lines, about half of this number being used at the present time. There are fifteen plugs to each position, with a full complement of supervisory signals, and combination ringing and listening keys. Each position has a cam by which the head sets on each position are connected together. The switchboard is of mahogany, of handsome cabinet construction, with the panels all removable for quick inspection and easy access.

The distributing frame is in the same room, and back of the switchboard. There is no intermediate rack used, all the lines from the cable suspended along the structure coming through the back of the building to the arrester side of the distributing frame. From this point the lines are jumpered across to connect with the distributing leads going to the switchboard.

Fig. 2 shows the relay rack, the distributing frame, and a portion of the back of the main switchboard. The plant is equipped with a standard wire chief's desk outfit, from which all tests can be made, and this equipment acts both as a monitor's and wire chief's desk.

Fig. 3 shows the power plant of this installation, and Fig. 4, the storage battery equipment. Fig. 5 shows the wiring plan of the back of the board. Every piece of apparatus in the power plant is duplicated, and the storage battery equipment consists of a double battery of twenty-two cells, making an equipment of forty-four cells in all. Current is received from the adjoining substation at 390 volts, alternating, three-phase, which runs a five-horse-power General Electric induction motor, direct-connected to a Holtzer-Cabot thirty-volt, 300-watt, direct-current generator. Compensators are installed for regulating the three-phase current, and a double set of Holtzer-Cabot ringers, taking twenty-four volts on the motor side from the storage batteries, and giving an alternating current at seventy-five volts from the generator. As may be seen from the wiring diagram, the negative side of both sets of batteries is made common. The charging current from the motor-generators is controlled by two switches which engage a common bus, across which the current from the charging machine divides itself through the two sets of the double battery of eleven cells, coming to the negative side of the charging generator through the common return. The

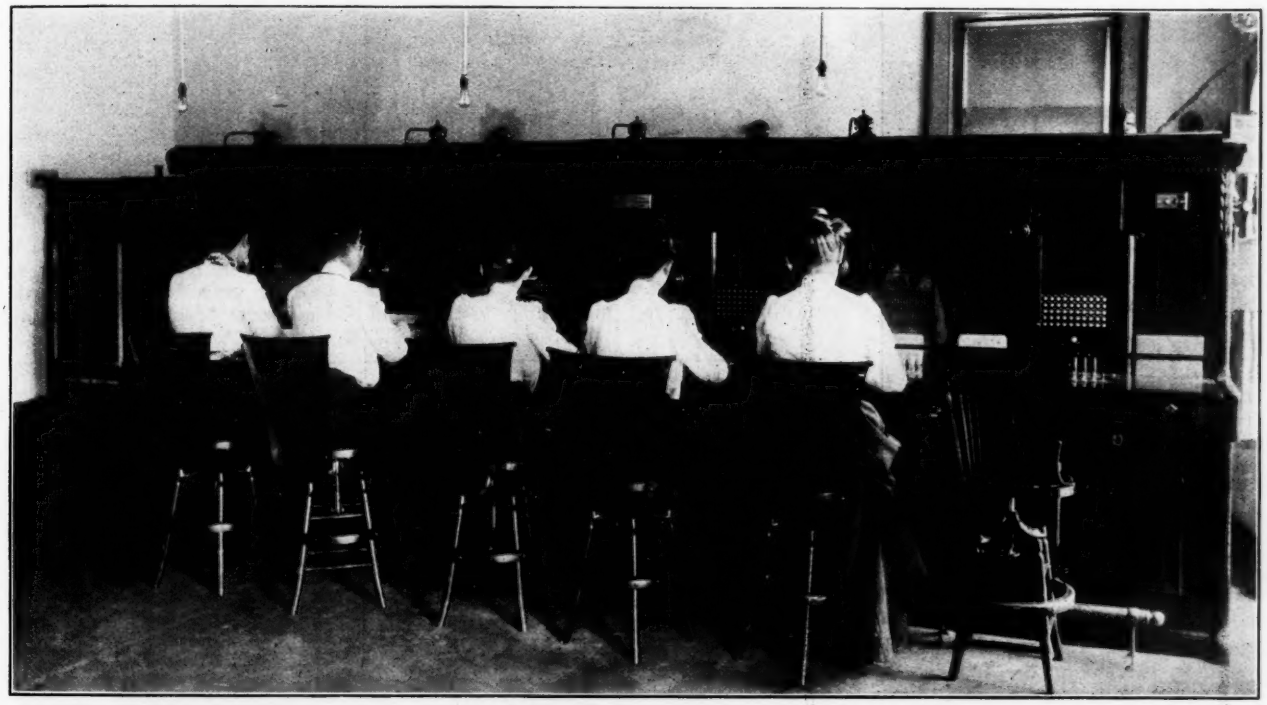


FIG. 1.—MAIN SWITCHBOARD AND FUSE ROOM, TELEPHONE EXCHANGE, MANHATTAN ELEVATED RAILWAY COMPANY, NEW YORK CITY.

positive discharge leads from the double set of cells are connected to a common bus, from which current is led to the fuse board, the negative side of either battery being common.

The switchboard is built of white marble, and is about six feet six inches by six feet six inches. At the extreme left side is the main switch for controlling the three-phase current from the substation, and a wattmeter for determining the amount of current used in operating the motor-generator.

In the centre of the board is the large switch which controls the common side of the battery. On either side of the large switch are the two charging switches which connect the positive leads from the charging generators to the storage bat-

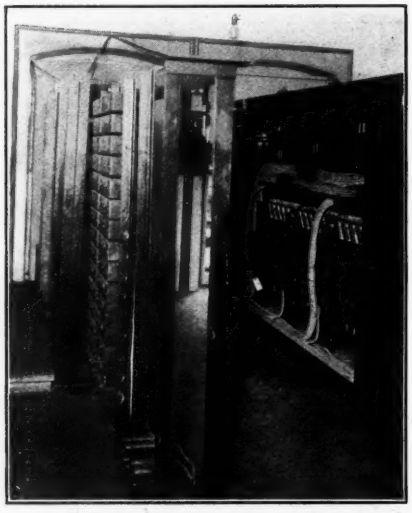


FIG. 2.—DISTRIBUTION FRAME, RELAY RACK, AND BACK OF BOARD, TELEPHONE EXCHANGE, MANHATTAN ELEVATED RAILWAY COMPANY, NEW YORK CITY.

teries. Below these are the switches which connect the discharge leads from the storage battery to the fuse board. There are two voltmeter switches, which are used to indicate the voltage on any individual cell, the voltage on the total number of cells in circuit, or the voltage of the charging generator. A regulator is connected in series with each generator for regulating the charging pressure, and two "I. T. E." circuit-breakers, one for each charging machine.

On the left-hand side is a bank of small switches for controlling the ringers. These switches are so arranged that the ringers may be thrown on either set of cells, and on to the fuse board. Besides the voltmeters at either end of the board, which are used in connection with the voltmeter switch, there are two ammeters which measure the current from both charging machines, and an ammeter in the centre which measures the total discharge current from the batteries.

On the fuse board, which is shown in Fig. 1, at the extreme left of the illustration, each of the generator leads is fused through an incandescent lamp, which is inserted between the generator and the point of use. The positive side of both batteries and fuse strip for the cord circuits is in a vertical position, the common negative being at the back of the board. At the bottom of the board is the fuse strip for the lamps, jacks, transmitters, etc., and immediately to the right of the fuse board is the retardation coil rack.

At the present time there is an average of about 1,400 calls per day. Each station in the Manhattan Railway service is equipped with a telephone instrument, and the service will be greatly extended. It is probable that the telephone service will eventually be substituted for the Morse system now more or less in use. Telephones are being used for despatching and for all sorts of official communications. With the completion of the Interborough Rapid Transit system, the exchange will probably be the central of a very complete independent service.

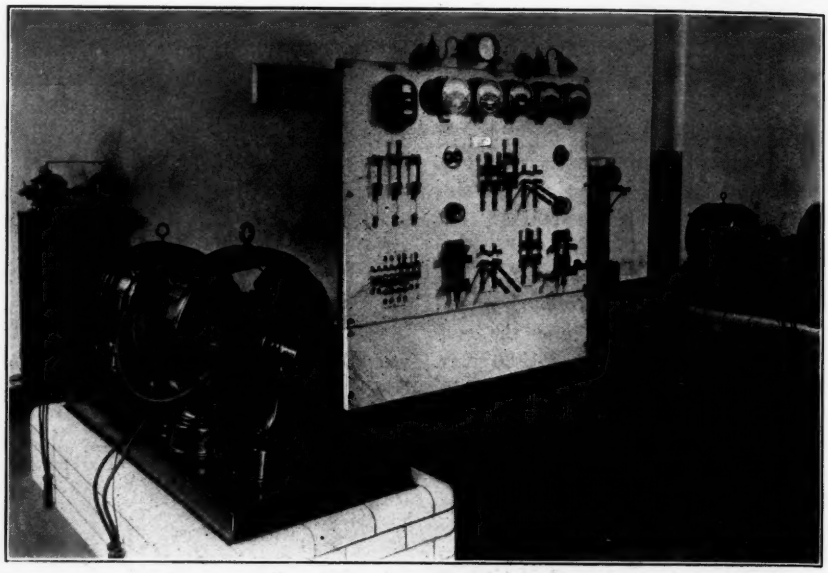


FIG. 3.—POWER PLANT, TELEPHONE EXCHANGE, MANHATTAN ELEVATED RAILWAY COMPANY, NEW YORK CITY.

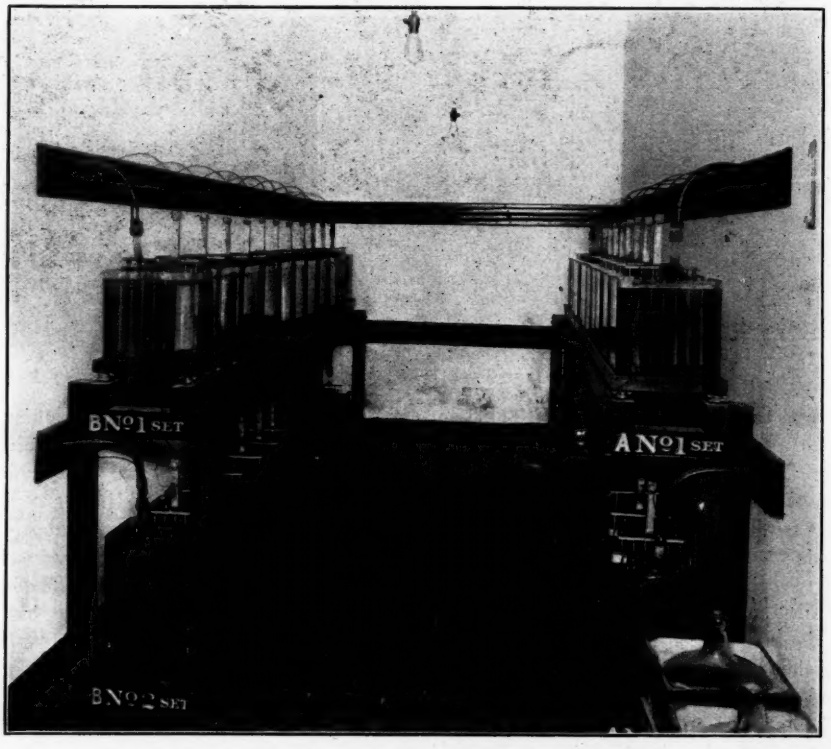


FIG. 4.—STORAGE BATTERIES, TELEPHONE EXCHANGE, MANHATTAN ELEVATED RAILWAY COMPANY, NEW YORK CITY.

THE TWENTIETH ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

GENERAL PROGRAMME.

The twentieth annual convention of the American Institute of Electrical Engineers will be held at Niagara Falls, N. Y., June 29 to July 3, 1903, and the meetings will be held in the convention hall of the Cataract House.

The following programme has been announced:

MONDAY, JUNE 29.

Institute and President's Day, 9.30 to 1.

Address, President Scott.

"Institute Branch Meetings, Their Organization, Development and Influence," by Calvin W. Rice.

"The Storage Battery in Substations," by W. E. Goldsborough and P. E. Fansler.

"Notes on the Operation of Railway Motors in Service," by Clarence Renshaw.

Afternoon, 2.15—Technical tour of inspection of electrochemical and other electrical installations operated by Niagara Falls power.

Evening—Dance under the auspices of Local Committee at Cataract House.

WEDNESDAY, JULY 1.

Niagara Day, 9.30 to 1—Power transmission papers:

"On the Testing of Electrical Apparatus for Dielectric Strength," by P. H. Thomas.

"Choice of Frequency for Very Long Lines," by P. M. Lincoln.

"Methods of Bringing High-Tension Conductors into Buildings," by C. E. Skinner.

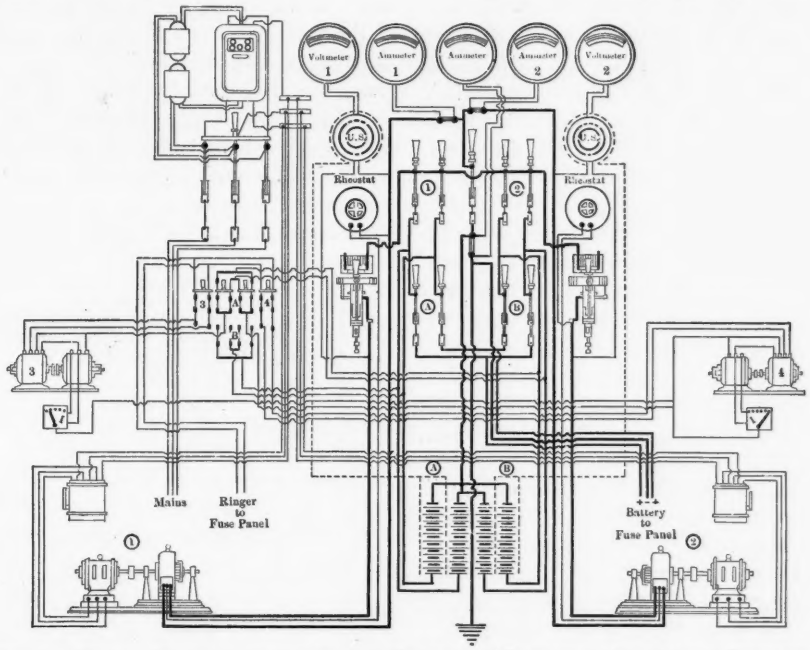


FIG. 5.—WIRING DIAGRAM, POWER-BOARD, TELEPHONE EXCHANGE, MANHATTAN ELEVATED RAILWAY COMPANY, NEW YORK CITY.

"The Energy Transformations in the Synchronous Converter," by W. S. Franklin.

"Commercial Alternator Design," by W. L. Waters.

Afternoon—Visits to local points of interest No prearranged programme.

Evening—"An Exhibition of the Hewitt Converter and the Mercury Vapor Lamp," by P. H. Thomas.

TUESDAY, JUNE 30.

Electrical Day, 9.30 to 1—Railroad papers:

"High-Speed Electric Railway Problems," by A. H. Armstrong.

"Storage Battery Industrial Locomotives," by Frank L. Sessions.

"Predetermination in Railway Work," by F. W. Carter.

"Car Run Tests," by W. E. Goldsborough and P. E. Fansler.

"Some Recommendations Concerning Electrical and Mechanical Specifications for Trolley Line Insulators," by Samuel Sheldon and J. D. Keiley.

"Y or Δ-Connection of Transformers," by F. O. Blackwell.

"The Grounded Wire as a Protection against Lightning," by Ralph D. Mershon.

"The Operation and Maintenance of High-Tension Underground Systems," by Philip Torchio.

"Electric Cables for High-Voltage Service," by Henry W. Fisher.

"The Use of Automatic Means for Disconnecting Disabled Apparatus," by H. G. Stott.

Afternoon—Trolley trips to Niagara Gorge, Fort Niagara, Brock's Monument, Chippewa. Technical visits to following plants: Niagara Falls Hydraulic Power and Manufacturing Company; Canadian Niagara Power Company; Natural Food Company.

Evening—Entertainment, Cataract House, under auspices Local Committee and General Committee.

THURSDAY, JULY 2.

Excursion Day, 9.30 to 1—Miscellaneous papers:

"The Factors which Affect the Energy Losses in Armature Cores," by J. Walter Esterline and Clarence E. Reid.

"Central Station Economies," by W. E. Goldsborough and P. E. Fansler.

"The Electrical Equipment of a Gold Dredge," by R. L. Montague.

"The International Electrical Congress of 1904," by Elihu Thomson.

"The Legalized Standard of Electromotive Force," by H. S. Carhart.

"Symbols and Nomenclature," by Carl Hering.

"A Universal Telegraphic Code," by G. C. Squier.

"The Magnetic Units," by A. E. Kennelly.

"The Cathode Ray Alternating-Current Wave Indicator," by Harris J. Ryan.

"Some Notes on Certain Underground Hoisting Problems on the Witwatersrand," by A. W. K. Pierce.

Afternoon—Technical excursions to Olcott Beach, St. Catherines, Lockport, Tonawanda substation.

Evening—Illumination of Gorge Route.

FRIDAY, JULY 3.

Buffalo Day, 9.30 to 1—Joint meeting with the Society for the Promotion of Engineering Education. Papers will be presented by the following members of the Institute:

"The Teaching of Physics to Electrical Engineering Students," by W. S. Franklin.

"The Problems That Are Facing the Electrical Engineer of To-day and the Qualities of Mind and Character Which Are Needed to Meet Them," by J. G. White.

"The Proper Qualifications of Electrical Engineering School Graduates, from the Telephone Engineer's Standpoint," by Bancroft Gherardi, Jr.

"The Proper Qualifications of Electrical Engineering School Graduates, from the Manufacturer's Standpoint," by L. A. Osborne.

"The Education of the Artist in the Forces of Nature," by E. H. Mullin.

"Engineering English," by T. J. Johnston.

Afternoon—Technical trips to Buffalo, Buffalo General Electric Company, Buffalo terminal house. Adjournment of Institute convention.

The following committees have been appointed:

Convention Committee — President, Charles F. Scott; secretary, Ralph W. Pope.

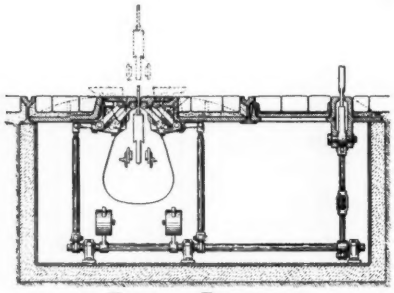
General Committee—George F. Sever, chairman; E. H. Mullin, J. W. Lieb, W. S. Barstow, Samuel Sheldon.

Local Committee—H. W. Buck, chairman, S. N. Whittemore, C. W. Underwood, L. S. Boggs, C. E. Acker, J. C. Calisch, De L. Rankine, H. V. Alverson, J. E. Montague.

Transportation Committee—E. H. Mullin, chairman, E. B. Katté, L. S. Boggs, assistant to secretary, G. A. Wardlaw.

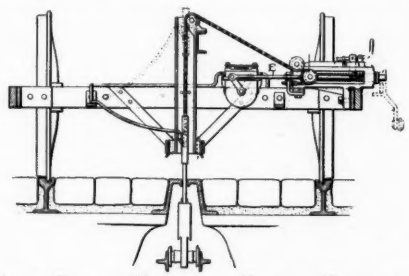
Electrical Patents.

Mr. Albert N. Connett, of London, England, has obtained two patents in this country on improvements in electric railways, and has assigned both to the General Electric Company, of New York. One of the inventions relates to electric railways of the conduit type, wherein the conduit is any suitable enclosure for protecting the electric conductors which supply the vehicle motors and wherein a collector or plow which is suspended from the vehicle extends through a slot in the upper portion of the conduit and makes electrical contact with the conductors in the conduit. The invention consists in means for moving a portion of the enclosure in order that when necessary the plow may be removed therefrom. The slot through which the collector extends into the conduit is necessarily very narrow in order to prevent vehicle wheels and other objects from entering it, and hence the shank of the plow must be very



Electric Railway.

narrow in order to have free movement within the slot. Furthermore, it is necessary that contact-shoes or current-collecting mechanism on the lower portion of the plow within the conduit should be of considerable size in order that they may be successfully operative. Hence it will be evident that the plow can not be raised or lowered through the slot and that some means must be provided for temporarily removing a portion of the upper wall of the enclosure or of widening the slot. Usually a plow is attached to the car in the car-barn, where the car is located over a large hole or open portion of the conduit; but there are several reasons why it is desirable or necessary to provide means out on the road for removing the plow from the conduit. The chief of these occurs in the combined urban and suburban roads where the conduit system is used within the city limits and the overhead line is resorted to in the suburbs, the cars being adapted to receive current from either system. In this case it becomes necessary to remove the plow from the conduit when the end of the conduit system is reached and to lower the plow into the conduit on the return trip, when the end of the overhead system is reached. In other cases it may be desirable to remove a damaged plow from a car without first pushing the car to the barn. These difficulties have previously been recognized and have usually been overcome in practice by stationing a workman at the end of the conduit, who, when the car came to a stop, would make the necessary changes, which in some cases consisted in removing the plow from the car. In a railway equipped with the present improvements, however, it is not necessary for any one to descend into the conduit nor to work beneath the car. The apparatus is such that the motorman or conductor can from the car platform, in a manner similar to which a road-switch is operated or from a position in the roadway alongside the car, actuate the mechanism which controls the conduit cover or covers to move the latter, so that the conduit plow may subsequently be removed from or lowered into the conduit in any suitable manner. The structure comprises covers arranged to close an enlargement in the conduit slot and supported on double links, which when operated raise the covers, and at the same time separate them sufficiently to permit the passage of the plow. The levers are connected by vertically disposed links with cranks attached to a rock shaft, which shaft is journaled transversely of the track and beneath the conduit. This rock shaft has counterweights and is provided at one end with a crank arm having an adjustable link connection with an actuating lever disposed at one side of the track. To open the conduit, therefore, it is only necessary to swing the exposed end of the actuating lever in one direction, thereby rocking the shaft and raising the covers. The other plan relates to the means for raising and lowering the plow after the conduit has been opened. In normal operation, this plow is suspended from the car by a chain at such an elevation that its contacts or shoes can engage with the working conductor rails. Means are provided at the side of the car whereby the chain can be controlled. The motorman having removed his controller handle may use it to operate such means to raise or lower the collector. Angle-irons are suitably secured to the truck-frame to engage the fore and aft portions of the collector, and thus prevent independent longitudinal movement of the same with respect to the cars. Guides are also mounted upon the truck-frame to engage the collector shoes when the collector is raised, and thus maintain the shoes in a central position to prevent them from catching on the guides. A suitable pulley is journaled upon the frame above the collector or plow and constitutes supporting means for the latter, a chain passing over the pulley and beneath a guide-wheel journaled upon a stationary portion of the track. Arranged transversely beneath the car is a worm-shaft on which is mounted a traveling nut, and to this nut is secured a wheel over which the supporting chain passes, the end of the chain being secured to a suitable stationary support. It will therefore be understood that when the motorman's controller handle is placed on the outer end of the worm-shaft and the handle turned, the nut carrying the wheel will be moved along the shaft and the chain will thus be raised, consequently elevating the conduit, which has first been opened to permit its withdrawal. When the collector has nearly reached its raised position, the shoes engage the inclined guides and will

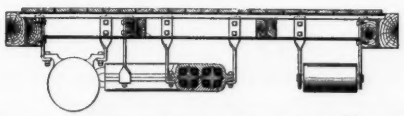


Plow Raising Means for Conduit Railway.

maintain them in a central position. A spring-operated latch is employed to engage the nut and prevent its return under the weight of the collector. This latch is released by the hand when it is desired to again lower the plow. In systems of this character, it is essential that the electrical connections of the collector, which has been withdrawn from its operative position, should be broken and that the electrical connections of the collector which are substituted should be made at that time. This has heretofore been accomplished by hand, but the inventor has devised means by which these changes are made automatically during the operation of raising and lowering the collector.

A new system of mounting and wiring electrical apparatus on motor cars has been devised by Mr. George Gibbs, of New York, N. Y., who explains his invention as follows: The present invention relates to an improved system for installing electrical apparatus on electric motor cars, and it concerns itself not only with the proper mounting of the apparatus mentioned, but also with the wiring of the

car and apparatus, the whole being designed to protect properly the car itself and the electrical apparatus from fire or other dangers due to the formation of electric arcs under conditions as they now exist. Insufficient attention has hitherto been paid to the proper wiring of motor cars and the proper installation of electrical apparatus generally from the standpoint of fire protection. Dangers are liable to arise even with the most careful attention to the installation of the wiring and apparatus, and for this reason one feature of my invention is concerned with the proper construction of the car itself. The remaining novel features of the invention reside in properly locating the apparatus and the wires and properly installing, insulating and protecting them, with the ultimate view of protecting the cars as well. The best location for the apparatus, including the wires, the circuit-breakers, the fuses and the like, is underneath the car body. To protect and insulate the wires and apparatus, they are covered as far as possible with a sheathing or envelope of some good insulating



ELECTRIC MOTOR CAR AND SYSTEM OF WIRING AND MOUNTING APPARATUS.

and fire-protecting material, such as transite, electrobeston, uralite or other asbestos compound, and are separated with their covering, by an air-space from all the inflammable or metal parts of the car, not only for the purpose of minimizing the danger of the arc coming into contact with the wooden or metal portions of the car, but also in order to permit the arc to be dissipated without the concentration of its heat upon any one spot, which is a danger that always exists when the wiring is run close to the inflammable or metal parts of the car or is confined, say, within an insulating tube which itself rests against or close to such metal or inflammable portions. The inventor does not rely solely upon the use of a sheathing of fire-resisting materials to protect the car from the effects of an arc when a wire is broken, knowing that a powerful electric arc concentrated upon a small portion of such a sheathing will eventually dissipate the fire-resisting material of the sheathing and endanger the neighboring parts of the car, and he provides for the dissipation of the arc and the further protection of the car by surrounding the sheathing of fire-resisting material with a considerable air-space. Moreover, he places underneath the car bottom, between it and the wiring, a sheet of good fire-resisting material—such, for example, as that described above—this sheet being permanently attached to the car bottom and being secured, as far as possible, as an unbroken sheet under the entire surface of the car. This sheet may be secured in any suitable manner, as by nails or screws, to the car sills, bridging, etc. He may construct the car with a double floor having its two parts separated by a fire-resisting sheet, or place such a sheet directly under the floor of a car provided with a single flooring. In either case, or whatever the character of the floor may be, an air-space is left below the floor and an enclosing sheet or lining of fire-resisting material below the car is provided. Thus he may apply the enclosing sheet or lining to a car of metal, such as steel, the purpose then being to prevent any arcing against the metallic portions of the car.

A New Annunciator System.

A new annunciator system has been designed by Herr von R. Dachsel, with the idea of reducing the number of circuits required, and which is described in the *Elektrotechnischer Anzeiger*. With the ordinary system each button requires one independent wire, though many may be grouped together on a common return. In the new arrangement two or more return circuits are used. The buttons are then grouped so that those having the same return circuit are connected to separate outgoing circuits, and those on the same outgoing circuits are connected to separate return circuits. Thus, supposing there are four buttons, four lines are required, two outgoing and two return. There is an annunciator drop in each circuit. Those on the outgoing circuits show numbers, those on the return showing colors. Thus, if button No. 1 is pressed, a drop falls showing two numbers, 1 and 2, on different colored backgrounds. A second drop opens, showing one color, indicating that that number having the same colored background as the second drop is the number of the button which has been pushed. The system here outlined is the simplest form, as a combination of three or more numbers to a drop, or three or more colors, enables a further saving of wire to be made.

German electrical interests are petitioning the government officials to arrange in making a new commercial treaty with Russia for lower duties upon German electrical supplies. At the present time about 20,000,000 marks' ($4,760,000) worth of electrical goods is exported to Russia from Germany annually, and the amount is increasing from year to year.

The Committee on the Organization of the International Congress of Electricity.

The International Congress of Electricity will be held during the week beginning September 12, 1904, at St. Louis, Mo., at the Universal Exposition. This period—September 12 to 17—immediately precedes the week of the Congress of Arts and Sciences, which will be a notable gathering of scientists, eminent in all departments, who will gather from all parts of the world. It is stated that advices from abroad indicate that from 400 to 500 electrical engineers will be in attendance at the congress. The American Institute of Electrical Engineers, the American Electrotherapeutic Society and the National Electric Light Association have thus far decided to hold meetings in St. Louis in conjunction with the International Congress of Electricity during this week.

On the recommendation of Howard J. Rogers, the director of congresses, President Francis has appointed the following Committee on Organization to promote the congress, issue the invitations and prepare the official programme:

President—Elihu Thomson, of Swampscott, Mass.

Vice-presidents—Professor H. C. Carhart, University of Michigan; C. F. Scott, Pittsburg, Pa.; W. E Goldsborough, Purdue University, and Dr. W. S Stratton, Washington, D. C.

General secretary—Dr. A. E. Kennelly, Harvard University.

Treasurer—W. D. Weaver, New York city.

Advisory Committee—B. J. Arnold, Chicago; B. A. Behrend, Cincinnati; C. S. Bradley, New York; J. J. Carty, New York; A. H. Cowles, Cleveland; Professor F. B. Crocker, New York; Dr. L. Duncan, Boston; H. L. Doherty, Denver; R. A. Fessenden, Norfolk; W. J. Hammer, New York; C. Hering, Philadelphia; L. B. Stillwell, New York; C. P. Matthews, Purdue University; R. D. Mershon, New York; K. B. Miller, Chicago; Dr. W. J. Morton, New York; Dr. E. L. Nichols, Cornell University; Professor R. B. Owens, McGill University (Montreal); Dr. F. A. C. Perrine, Pittsfield, Mass.; Professor M. I. Pupin, New York; Professor J. W. Richards, Lehigh University; Professor H. J. Ryan, Cornell University; William Stanley, Great Barrington, Mass.; Professor C. P. Steinmetz, Union College, and A. J. Wurts, Pittsburg.

Reviews of Current Engineering and Scientific Literature.

Motor Cars for Delivering Freight.

This article first discusses the use of detachable motors for drawing vans, and takes the stand that this service is not satisfactory, because this arrangement is more difficult to guide, particularly on restricted roads, and also because the motor would gain no added adhesion due to the load, and, unless made very heavy, would not be able to ascend grades. The article then discusses the showing made by a type of English steam wagon. The wagon has a capacity of from four to five tons. It is about eighteen feet overall, four or five feet being taken up by the machinery. It is not thought suitable for light service, and at the present time it is not deemed possible that a motor-driven vehicle can compete with horses for this work. A van of this kind will cost, at the outside, not more than $3,500. The expense of operating for one year is estimated as follows:

Interest on the capital at 4 per cent	$140
Depreciation and maintenance at 10 per cent	650
Wages of driver	455
Wages of assistant	325
Coal	350
Oil and stores	75
Making a total of	$1,995

The vehicle may be expected to take a load of four tons out a distance of fifteen miles, and return an equal distance with a load of three tons, and it will do this five days per week for fifty weeks, allowing a fortnight for thorough overhauling. This work amounts to 525 net ton-miles per week, or 2,625 net ton-miles per year, and therefore the total cost of carrying one ton one mile will be about 7.2 cents. This figure, it is stated, is very liberal, as wagons of this type are now operating at a cost of not more than four cents per ton-mile.—*Abstracted from the Railway News (London), May 30.*

Crystallization in an Electric Field.

A crystal, when placed in a magnetic field, sets itself so that the direction of its greatest dielectric constant lies along the field. This fact suggested to Herr von W. Schmidt that possibly an electric field might have some effect upon crystals as they are formed from a solution, and he here describes an experiment undertaken to test this idea. The solution used was sulphur in carbon disulphide. This was placed in a glass vessel closed by an air-tight wooden cover. The electrodes were pieces of brass-foil placed parallel and connected by wires passing out through glass tubes to an influence machine. A third tube was carried to an exhaust pump. The potential difference was maintained at about 40,000 volts. The solution used was not saturated at the beginning of the experiment. After the experiment had progressed for something over half an hour, crystals were noticed on the back of the anode. After one hour crystals were formed also on the front of the anode, but in smaller number than on the back; and an hour later, they were noticed forming on the wall of the vessel behind the anode plate. These crystals were formed in the neighborhood of the anode only, and not on the cathode, but they showed no orientation. The phenomenon may be explained by assuming that sulphur crystals at the moment of formation have a negative character. They would then be driven away from the cathode.—*Translated and abstracted from the Physikalische Zeitschrift (Leipsic), June 1.*

The Application of Electricity in Spinning and Weaving Mills.

An interesting application of the electric drive in spinning and weaving mills is here described by M. A. Grangé. The mills of Messrs. David Adhemar & Maigret had an electric lighting installation, and when it was found necessary to extend the mills, it was decided to use the motor drive. The lighting system was a continuous-current series arc system, and it was thought desirable to retain this machinery. This generator was driven by a steam engine, but the company had also a small water power. It was decided to use three-phase induction motors for driving the machinery. For this purpose a three-phase alternator, with an output of 280 horse-power at 500 volts, was installed. To obtain the power necessary to drive this machine a second cylinder was added to the old engine, converting this into a compound engine. A 100-kilowatt double-current generator was installed, driven by a turbine; and a storage battery equipment with an output of 300 ampere-hours was added. The latter is used to run the lamps during the night, and in starting up. One of the disadvantages of the motor drive was thought to be the necessity of starting each motor independently. To avoid this, the motors, which are of the induction type with squirrel-cage winding, are left connected to the circuit at all times. When the plant is started in the morning, the generator is excited from the battery, and then the engine is started. As this speeds up, it brings the motors up with it. As it would seldom be necessary to start a single motor, the disadvantage of having to stop and restart the entire plant, should this be necessary, is slight. The batteries are charged from the double-current generator, which also furnishes current for the arc lights, and, through transformers, power for running the motors in the repair shops when the main generator is shut down.—*Translated and abstracted from l'Electricien (Paris), May 30.*

A New Surface-Contact System.

The General Electric Company, Limited, of London, England, has developed a surface-contact system which is designed to meet the requirements of city traction, where the overhead trolley is not permissible and where a conduit system would be prohibitive on account of the cost. Current is distributed by means of contact buttons placed between the rail, and projecting five-eighths of an inch above the head of the rail. There are two series of these buttons, one for supplying the current to the motors, and the other for operating the automatic switches. The return current is carried by the rails. The contact switches consist of solenoids attracting iron cores. The core carries at its lower extremity three carbon blocks which make contact, when the core is raised, against three brass terminals. One of these is connected to the supply mains, and the other two to successive contact buttons which supply the current to the motors. The car carries two skates, of sufficient length to span the distance between two successive contacts. The car also carries a small accumulator set for starting. The system operates as follows: As the car moves, one skate is in contact with a positive contact, and the other with a negative. Current is then supplied through the automatic and the positive skate switch to the motors, then through the other skate and the negative contacts to the operating solenoid, and thence to the rail. As the car moves, the negative skate comes in contact with a second negative contact. The motor current is then divided be-

tween the coil of the switch which has been in operation and that of the next switch. The latter is closed, and thus places the next positive contact in communication with the feeder. As the car moves and the negative skate leaves the negative contacts, the circuit is opened and the switch falls by gravity and breaks the circuit at that point. To avoid binding, the movable core is sheathed with brass and moves loosely within a brass tube. The automatic switches are grouped in vaults at intervals of about 300 feet along the line. Except for the addition of the skates and the small accumulator and means for charging this, the car equipment does not differ from the standard series parallel arrangement.—*Abstracted from Engineering (London), May 29.*

Induction Phenomena of the Mercury Arc in a Magnetic Field.

Herr J. Stark has studied some interesting phenomena observed in a peculiar form of mercury vapor lamp. The shape of the lamp used was a rather long curved tube, to the centre of which was attached a condensing chamber. When the arc is started, the temperature of this condensing vessel is less than that of the tube, and condensation of the mercury vapor begins to take place. At first an ellipsoidal glow appears, which becomes a striated column of glowing vapor, and, finally, a uniform, intense, reddish, luminous stream. Where this column approaches the fluid mercury in the bottom of the condensing vessel it spreads out into the form of an inverted mushroom. When the electrodes of the lamp are heated in any way, the mushroom-shaped bottom of the ray in the condensing vessel increases, showing a more rapid inflow of vapor. If one of the electrodes is heated, the ray is deflected toward the other side, indicating a greater flow of mercury vapor from the hot electrode. With a special type of lamp, which had platinum electrodes fused into the condensing chamber, an electric current could be sent through the column of vapor. When one of these electrodes was coated with mercury, the other being bare, there was a difference of electromotive force between the two. By setting up a magnetic field normal to the plane of the electrodes and to the direction of the column of vapor, a difference of potential was established between the two electrodes. Knowing the strength of the field, and measuring the difference of potential, the author was enabled to calculate the velocity of the column of mercury vapor. This was shown to be dependent merely upon the difference in pressure between the condensing vessel and the lighting tube. Placing a horseshoe magnet around one end of the lamp, the column of luminous vapor was deflected to one side; but where this column started from the mercury, at which point it burrows down into the mercury, the deflection took place toward the other side of the tube. The apparent paradox is explained by a local difference in temperature set up at that point.—*Translated and abstracted from the Physikalische Zeitschrift (Leipsic), May 1.*

The Magnetic Observatories of the United States Coast and Geodetic Survey in Operation July 1, 1902.

This article by Messrs. L. A. Bauer and J. A. Fleming, gives a quite detailed description of the sites selected for these observatories, and explains the design of the buildings and the apparatus installed. There are four observatories, the principal one being at Cheltenham, Md., fourteen miles southeast of Washington. This is the standard magnetic observatory where, in addition to the regular observatory work, all magnetic instruments are standardized. The second observatory is located at Sitka, Alaska. The third is twelve and one-half miles west of Honolulu, Hawaii; and the fourth, at Baldwin, Kan., thirteen miles south of Lawrence. A fifth observatory will probably be established in the western states, but the site has not yet been selected. It is also contemplated to erect a magnetic observatory in Porto Rico. In selecting the sites great care was necessary to secure locations free from local magnetic disturbances, and in sections not likely to be encroached upon by electric railways within the next fifteen years, during which time the magnetic survey of the United States will be made. In constructing the buildings it was necessary not only to avoid all use of magnetic material, but to provide constant-temperature rooms. The Cheltenham building, which is the most elaborate, consists of two sections, connected by a corridor. The foundations are of marble, obtained in the locality, this being found free from all magnetic properties. The building, itself, is of wood, and consists of four shells. The spaces between the outer two and the inner two are filled with sawdust, the intermediate space being left free for passageway. The ventilating system is very carefully designed, and it was found that with this construction the mean annual range within the room was reduced to about one-half a degree Fahrenheit. The laboratory is equipped with an Eschenhagen magnetograph, an Adie magnetograph, a Wild-Ebelman earth inductor, galvanometers, and other necessary instruments.—*Abstracted from Terrestrial Magnetism and Atmospheric Electricity (Baltimore), March.*

A Mercury Interrupter for Alternating Currents.

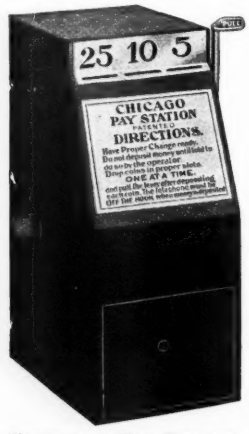
This article by M. G. Davy describes the Villard interrupter for obtaining unidirectional currents from an alternating-current circuit. The action of the apparatus depends upon the synchronous make and break of an oscillating contact dipping into mercury. The vibrating part is a strip of soft iron, placed between the arms of the premanent magnet of the horseshoe type. Over this strip is slipped a coil of wire through which an alternating current, taken from the same supply, is sent. The effect of this alternating current is to set up an alternating magnetization of the soft iron strip, and to set this in vibration. To the end of this vibrating part is attached a light rod which dips into the mercury. Synchronous operation is obtained by a proper phasing of the current passed through the coil, and suitable damping of the vibrating strip. When the damping is sufficient, the strip will follow the alternations of the flux independently of its own period of oscillation. To secure proper phasing, a combination of an inductance coil and resistances is used. This arrangement makes it possible to cause the current through the coil to lag behind the electromotive force by any desired amount, and since the motion of the vibrating strip will lag behind that of the current, this motion can be brought into phase with the current through the contact. When the apparatus is in operation it is necessary to adjust the reactance and resistances so that there is no spark when the circuit is broken. Curves of the performance of this apparatus were obtained by means of the Hospitalier ondograph. If the load is connected in series with the regulating inductance, only one-half of the electromotive force wave is utilized. It is possible, however, by the combination of shunt circuits and inductances, to obtain a fairly constant current. In charging accumulators, the apparatus is adjusted so that the circuit is closed only during that part of the cycle in which the electromotive force of the circuit is greater than that of the batteries. An apparatus of this type, delivering ten amperes at 110 volts, showed an efficiency of ninety-five per cent.—*Translated and abstracted from l'Industrie Electrique (Paris), May 25.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Telephone Pay-Station Development.

The plan of operating public telephone stations with an automatic coin collector, by which the central office operator is enabled to collect the cash in advance for each conversation, has steadily grown in importance from its introduction up to the present time. The installation of such



TELEPHONE PAY STATION.

coin-collecting devices has proven very profitable to the telephone companies.

Various phases of the subject of message prepayment in telephone service have all come up for experiments by the operating telephone companies within the past few years, and in each experiment the introduction of a coin-collecting machine has proven a solution to the problem.

The machine used is a locked iron box

MESSAGE REGISTER.

containing slots for the deposit of coins of various sizes, and containing signaling devices, by which the deposit of each coin announces the deposit and the denomination of the coin by a code of sounds understood by the central office operator, and audible to her through the transmitter of the telephone set; the deposited coin, after giving its peculiar audible signal, passes into the locked box, from which the accumulated coins are taken by the telephone company's representative having the key or combination to the lock on the box.

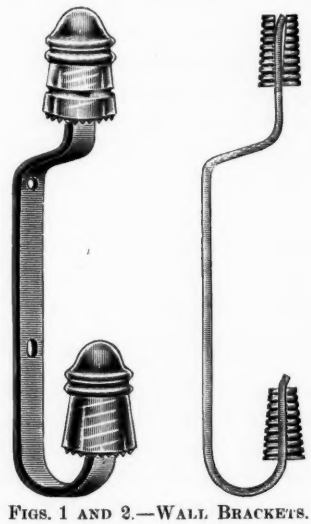
Great progress has been made during the past year in the matter of provision for the rapid handling of calls for which coins are collected in advance of the conversation.

The Chicago Pay Station Company, of Chicago, is now offering rapid service coin collectors, in which the operator does not wait to secure the connection desired before collecting the coin necessary for prepayment of the message; instead, the coin is taken at the time the called number is taken, and the calling party at that time deposits the coin in the usual way, thus producing the signal notifying the operator of the deposit. In case the party be obtained and the conversation successfully consummated, no further attention is given to the collected coin, but if for any reason the telephone company is unable to give the service required the operator presses a key on the telephone switchboard, this enabling her to return the last coin deposited in the coin collector. This method of collecting advance charge, which involves no delay to the conversation after the party called for answers his telephone, is an advantage over the method previously generally employed.

With the growth in the use of automatic coin collectors there has been corresponding increase in the use of the message register. The message register is a device containing a counter and some audible signal mechanism, conversation the operator requests the patron to "register," which is done by turning the key one revolution; this produces the audible signal recognized by the operator, and at the same time steps the counter forward one unit and thus the total number of conversations held is recorded at the end of the month, or any given period. The meter is read as a gas or water meter, *viz.*, the reading of the dials is taken, the last previous reading is subtracted and the telephone user is billed for the number of messages thus shown, at a fixed rate per message. This method has grown in favor during the past year and particularly for party lines, where the use of the measured rate not only permits the small user to obtain correspondingly low rates, but also tends to reduce the abuse of party lines and thus to make the service more satisfactory generally, both to patrons and to telephone companies.

Patented Construction Specialties.

From time to time objections have been raised to the use of wooden brackets on brick or stone walls, and efforts have been made in many directions to design a substantial and durable metallic bracket



FIGS. 1 AND 2.—WALL BRACKETS.

which would be easy of installation, and also be moderate in price. The accompanying illustrations show a line of specialties which are designated as the "Peirce" patented construction specialties, and for which the Illinois Electric

FIG. 3.—ANCHOR BOLT.

Company, of Chicago, Ill., is the general sales agent.

Figs. 1 and 2 show the "Peirce" bracket, which embodies an efficient and inexpensive method of attaching a glass insulator to a piece of bar steel. The bracket is made of one-quarter by one-inch Bessemer steel, galvanized. The ends of

the bar are slightly bent, and act as wedges to spread the split pins when these are drawn up by screwing the insulator on. It is claimed by the manufacturer that these brackets are cheap to install,

FIG. 4.—HAMMER DRILL.

and that the cost of labor is very much reduced, the maintenance expense being almost entirely eliminated.

Fig. 3 shows the "Peirce" galvanized anchor bolt, which has been especially designed for fastening these brackets to brick or stone walls. However, these may be used for any number of purposes, such as fastening telephones, porcelain knobs, glass knobs, etc., to brick walls. These anchor bolts take very little time for installation, and will stand a heavy strain; while requiring small holes, and making a firm and secure fastening.

Fig. 4 shows the "Peirce" hammer drill, and the function of this is for quick drilling in brick or stone walls. The illustration will show very clearly the operation of this drill, and the manufacturer claims that this possesses more than ordinary merit for this class of work. One

FIG. 5.—UNDER-HANG BRACKET.

end of the drill consists of a chuck and drill for boring, while the other end is a hollow punch which is used for expanding the lead sleeve on the bolt. In an ordinary brick wall a hole from three-quarter inch to one inch deep is made with the hammer drill. The anchor bolt is then inserted head first, and by using the punch end of the hammer drill the lead sleeve is forced back over the expansive head and into every crevice of the brick or stone.

Fig. 5 shows the "Peirce" under-hang brackets, which are used for temporarily or permanently doubling the capacity of cross-arms. These are so constructed that with their use the cross-arm is not weakened with bolt holes. The brackets are adjustable for any size of arm, and are easily put up, affording excellent insulation.

Fig. 6 shows the "Peirce" break-arms, which are used for breaking a through wire for a series drop, for dropping from the end of a route arm, or for a transposition. These are as easily put up as the under-hang brackets, and are designed in the same manner, so that the cross-arm is not weakened by the insertion of bolts. These are adjustable to any size of cross-arm. When used to drop from the end of an arm, they leave the end-route pin available. The same method of fastening the insulators is used with the break-arms and under-hang brackets as with the brackets illustrated in Figs. 1 and 2.

The "Peirce" specialties also include angle iron cross-arms, which are so designed as to present a neat appearance, and have great strength. These iron cross-arms also occupy but very little space on the pole, and do not afford a good landing for ice and snow, which will also tend to reduce troubles from this cause to a minimum.

A pole-top distributing circle with pole-houses is also a part of this line, several types of which have been placed on the market by this company. A pole set near the centre of the block is equipped with a distributing circle and pole-house, and is fed with either an underground or aerial cable. From this one pole the rear of every building in the block can generally be reached with a straight drop, for which twisted pairs of rubber-covered wires are used.

Fig. 7 shows the "Peirce" protected terminal head, which is used with the distributing circles just described. This is mounted above the distributing circle, with the door opening directly above the pole-top and facing the seat on the distributor, so that the lineman may easily reach any part of his work without changing his position. The pole-house is made of clear cypress, painted white inside and outside. The sides and front form the door, which is hinged to the back, and, when opened, allows free access to all wires and connections. The terminal head is made of iron, front and back, with fibre sides. The binding-posts by which the cable conductors are soldered on the inside are mounted upon the outer surface of the fibre sides. Tubular fuses pass through holes in the inner frame, and are screwed to the binding-nuts, affording firm and secure connections for the jumper wires. The fuses are held firmly in their horizontal position by the frame. This inner frame, with a glass front, completely encloses the terminal head, which is, itself, water and air-tight, and filled with cable compound. Each conductor terminal is numbered on the edge of the inner frame.

This line also includes a protected terminal head which is light and easily in-

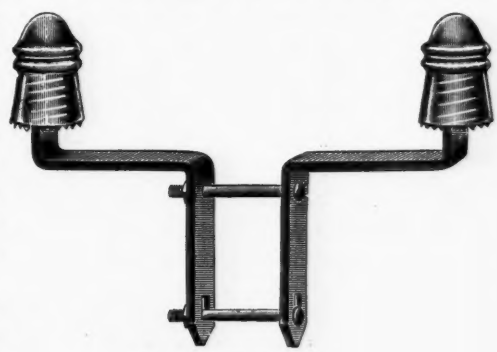


FIG. 6.—BREAK-ARMS.

stalled. The wiring and filling are done, and it is only necessary to splice the line cable to the end of a short piece of cable, which is furnished with the pole-house. These are claimed to be time-savers to distribute from or test from, as well as

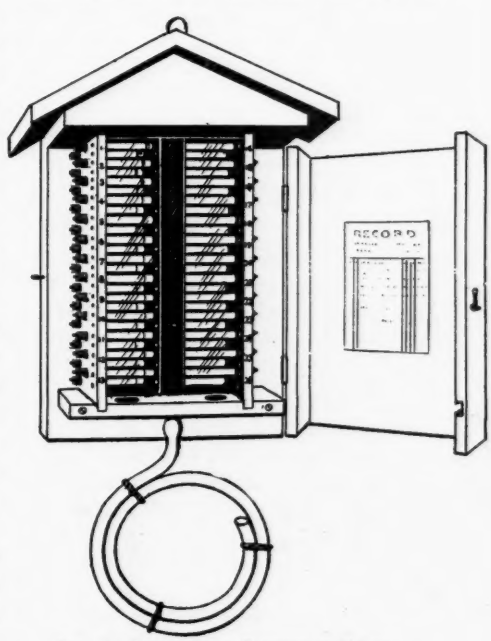
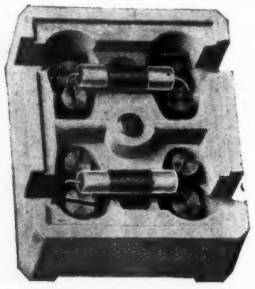


FIG. 7.—PROTECTED TERMINAL HEAD.

to install. They are furnished fused or not fused, but fused terminal heads are recommended where distribution is made to aerial lines. Where only short rubber-covered drop wires are used, this will not be necessary.

Enclosed Fuses.

The Electric Appliance Company, Chicago, Ill., has secured the exclusive sales agency for the new enclosed fuses known by the name of "McBride Arkless Fuses." This fuse is of new design, and is intended and adapted for use on every



NEW TYPE ENCLOSED FUSES.

possible fuse link connection. This brings it into use wherever an old-style link cut-out is in service.

An illustration herewith shows a fuse

NEW TYPE ENCLOSED FUSE.

in full size. This fuse consists of a cartridge, extending from each end of which is a copper wire sufficiently long to fit any link connection. These fuses are made for 125 volts, also for 250 volts, with capacities running from three to thirty amperes. This fuse is made to meet the requirements of the fire underwriters, and the company announces that many of the important cities in the country have approved its use.

A New Desk Telephone.

The Century Telephone Construction Company, Buffalo, N. Y., has recently placed on the market a new desk telephone, which combines in its make-up a number of new and excellent features. The design is simple and effective, and the set being fully nickel-plated makes it handsome and pleasing to the eye. The prominent feature of this instrument is the ease with which the switch can be inspected. By turning a lock-nut just above the hook it releases the two halves of the handle and exposes the entire switch without removing the receiver from the hook. One half of the handle is set on retaining pins in such a manner that it is impossible for it to turn. The other half is firmly locked in position by the screwing down of the lock-nut.

The hook is so arranged that it permits of the largest range of action, thus securing the most efficient make and break connections with the springs. The connections from the switch are made in the base of the telephone by being firmly soldered to the binding-posts which are mounted on a heavy fibre bridge.

The transmitter cord is so arranged that it does not in any way come in contact with the working parts of the telephone and is secured on binding-posts in the base. The receiver and terminal cords are connected to these binding-posts in the ordinary way. There is in the base a ring, upon which is firmly hooked both the receiver and the terminal cord, thus preventing any possibility of any strain being brought to bear on the electrical connections.

The centre stem, upon which the switch is mounted, is heavy and substantial and securely locked to the base. The base is enclosed with a felt-covered steel bottom.

The entire instrument is built so as to withstand a maximum amount of hard usage to which desk sets are usually subject.

The Saratoga Limited Train.

The inaugural trip of the Saratoga Limited train over the New York Central & Hudson River Railroad and the Delaware and Hudson Railroad was made on Saturday last, a party of newspaper men and ladies accompanying Mr. George H. Daniels, general passenger agent of the New York Central, on the trip. The Saratoga Limited is one of the three fastest trains in the world. It left New York at 1:50 P. M. Saturday, June 20, and arrived at Saratoga Springs about five minutes ahead of its schedule, making the fastest trip ever made by this train. It was composed of new café, parlor and observation Pullman cars, substantially and beautifully finished. This train will leave New York regularly during the season at 3:20 P. M., except on Saturday, on which day it will leave the Grand Central Station at 1:50 P. M.

The cars composing this train are among the finest ever turned out by the Pullman Company.

On the inaugural trip it carried the Saratoga Limited Club, an organization which annually visits Saratoga in this manner. The guest of honor was Commander Robert E. Peary, the well-known explorer. The daily and weekly press of New York city and Brooklyn, as well as Albany and Troy, was very completely represented, and among the railroad officials who accompanied the party were Mr George H. Daniels, general passenger agent of the New York Central & Hudson River Railroad; Mr. Charles J. Laing, secretary to Mr. Daniels; Mr F. J. Wolfe, assistant general passenger agent of the New York Central; Mr. J. W. Burdick, general passenger agent Delaware & Hudson Company; Mr. A. E. Brainard, general agent of the New York Central at Albany; Mr. V. V. Beard, assistant general eastern passenger agent of the Central; Mr. J. E. Root, advertising manager, and Mr. J. T. McKee, superintendent of the dining service.

On Saturday evening the annual meeting of the Saratoga Limited Club was held in the parlors of the United States Hotel, and the proceedings were of a very entertaining nature. It was presided over by President Daniels, who made a witty opening address, which was followed by the reports of the secretary, Louis Wiley, and the treasurer, Charles W. Price. The election of officers, for which a special ballot had been prepared, amusingly describing each candidate, followed, and the following gentlemen were unanimously elected: President, George H. Daniels; vice-president, William Berri; secretary, Louis Wiley; treasurer, Charles W. Price. Executive committee: J. W. Burdick, C. F. Smith, William Berri, John A. Sleicher, Pomeroy Burton, J. Arthur Seavey, H. T. Gunnison, T. E. Niles, H. J. Wright and Arthur A. Parks. Official poets: W. J. Lampton and R. K. Munkittrick.

Commander Peary was invited to address the club, and obliged with an intensely interesting description of his travels and adventures in searching for the North Pole. He was elected the first Honorary Member of the club.

The return trip was made Monday morning. En route, resolutions of appreciation of the courtesy of the railroads and of the United States, Grand Union, American and other hotels of Saratoga were adopted.

Mr. J. E. Root, advertising manager of the New York Central, met with an accident on Sunday morning, slipping and falling against his bathtub in such a way as to break his left collar-bone. While the accident was quite painful, the break was not a bad one, and Mr. Root expects to be out again in a few weeks. Mr. Daniels provided him with a special car, and he returned to New York city from Saratoga on Sunday afternoon.

Saturday, June 20, was the fiftieth anniversary of Mr. J. W. Burdick, the general passenger agent of the Delaware & Hudson, and also the twenty-fifth anniversary of his association with that road, and was the occasion of many congratulations to Mr. Burdick and a presentation to him by his office associates.

As this meeting of the club was its fifth anniversary, during which time Mr. George H. Daniels had been president, a very handsome wooden chair was presented to him by the club. Mr. H. D. Vought made the presentation speech, which was responded to by Mr. Daniels, both addresses being received with much applause.

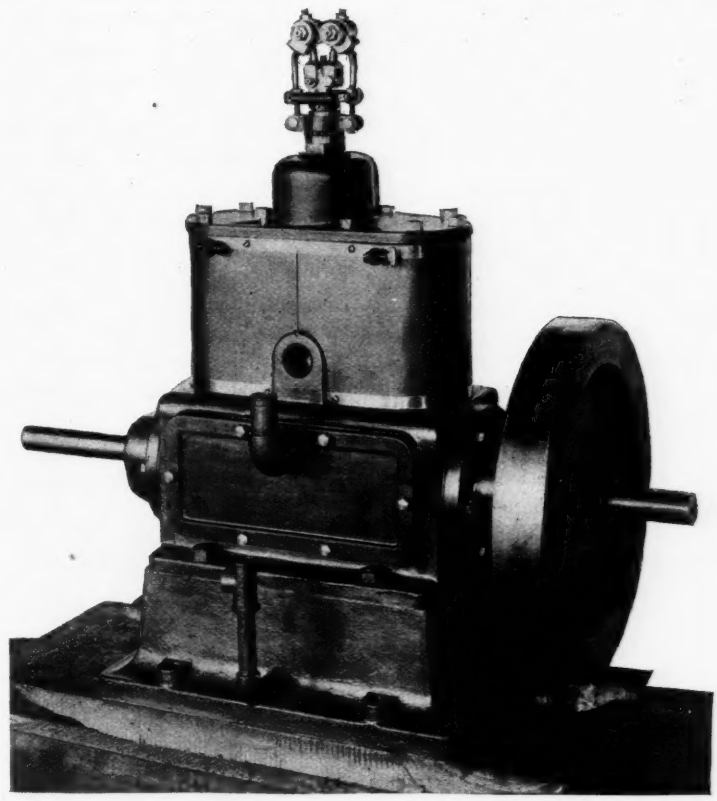
The Francke Four-Ported Engine.

The Francke engine is a vertical engine with two cylinders set side by side. Both pistons are single acting and are, therefore, built as trunk pistons and the connecting rods are fastened to them directly by a pin. The pistons, which act as cross-heads, are made very long in order to properly provide for the lateral pressure from the rods.

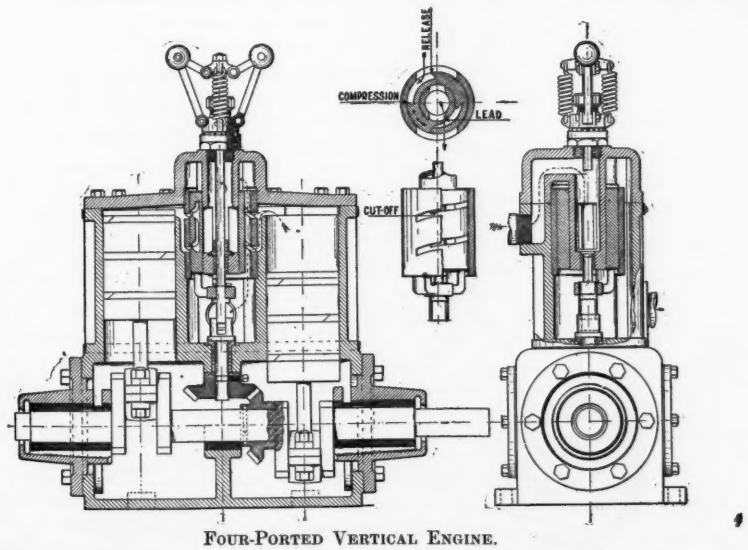
The valve, which serves both cylinders, is located between them, and takes the form of a vertical hollow cylinder mounted upon and rotated by a shaft which is bevel geared to the crank-shaft. This shaft extends up through the cylinder-head casting and drives a centrifugal ball governor which is mounted directly upon it, making the valve and governor one integral part.

The arrangement of ports is such that a perfect four-valve steam distribution is obtained with the use of but a single valve and the economy due to four-valve steam distribution is brought down to small units, while yet retaining the simplicity of the slide valve; in fact, the valve and valve setting are stated to be simpler than a slide valve.

The distinctive feature of the engine is a very simple valve which rotates continuously, is perfectly balanced on all positions and with which the following various steam distributions are obtained, *viz.*:



FOUR-PORTED VERTICAL ENGINE.



FOUR-PORTED VERTICAL ENGINE.

The valve may be set to give constant lead, release and compression and each one of these functions may be set at any point of the stroke, entirely independent of each other, and the cutoff under the control of the governor will be entirely independent of all and any of the other functions of the steam distribution; a valve so set will give the same steam distribution as a Corliss valve motion with the additional feature that the release and compression may be set at any point of the stroke independent of each other.

The valve may also be made to give a varying compression under varying loads, the compression increasing as the load gets lighter and decreasing as the load grows heavier, and the varying compression may be made small or great, as desired, without in any way changing the release or lead, which may be kept constant. The lead also may be made to increase as the load grows lighter and decrease as the load grows heavier, in any desired ratio, without changing the variation in the compression; and the variation in the lead and compression may be made to occur in different ratios or to begin at different times, and none of these changes will effect the release, which may be kept constant or may be also made to vary if desired.

Arbitrarily fixing the compression at any desired point makes it possible to get a proper cushion for any desired rotative speed; the compression can be fixed for a piston speed of 600 or even 700 or 800 feet, or it can be made so light that the engine may be run as slow as to just get over the centres, and as there is no reciprocating motion except that of the perfectly cushioned pistons, and the engine is reliable and durable at very high rotative speeds. The highest piston speeds at which the engines are rated is very conservative, considering these points, and is only 600 feet per minute.

The only parts of the engine that call for special explanation are the valve and its related parts. As already stated, the valve is tube-shaped with its axis vertical. It rotates in a cylindrical bushing which is inserted into the chamber between the steam cylinders; this bushing has ports

cut in it on opposite sides, communicating respectively with the interior of the two cylinders. The valve itself also has ports cut in it, adapted to register at the proper period with the ports in the bushing. The interior of the valve tube fits over a prolongation downward from the cylinder-head casting. This prolongation has a hollow or steam chamber formed within it; it is the steam chest, and suitable steam supply ports open outward from it; the remainder of the valve chamber is utilized as an exhaust steam space. The tubular valve itself is balanced longitudinally, since both ends are exposed to the exhaust steam. It is also balanced vertically, being made so that as it rotates the pressure is on it inside and outside during admission, expansion, release and compression, which occurs alternately on each side of the valve, balance each other and the valve can be pushed up and down by hand with 100 pounds of steam in the engine.

The admission port in the valve is cut entirely through the tube, so that it may connect the opening in the steam chest with the ports in the bushing. On the outside diameter of the valve tube this port is straight up and down, conforming to the shape of the port in the steam chest; the edge which is in advance during rotation opens for steam and is the "lead" edge.

The governor, seated on top of the cylinder-head casting and rotated by the vertical shaft, is of the ordinary centrifugal ball type. It is, however, easier of adjustment than the flywheel governor of the same type because it is infinitely lighter, the balls in the smallest size weighing only about three-quarters of a pound and the spring being only one-half inch in diameter. Ample and convenient means of adjustment are provided. The action of the governor raises or lowers the vertical shaft when the speed of the engine exceeds the proper limits. The upper part of the vertical shaft on which the valve is carried is so connected to the lower part of the shaft that it can move a short distance up and down.

If it should be desirable to have a varying compression, a valve having the exhaust port inclined is employed. Any desired amount of constantly increasing compression may then be had by simply changing the inclination of the port edge from the horizontal; it follows that the same thing can be done with the lead and release.

The valve is set by loosening the set screw that holds the gear to the vertical shaft, putting the engine on centre and turning the valve in the bushing when the lead, cutoff, release and compression can be seen through the ports in the bushing and set as desired. In the larger engines the main bearings are oiled by a chain taking oil from a reservoir cast in the bearing and independent of the crank case, the chain always being in sight.

The subbase is utilized for separating the water condensation from the lubricating oil in the crank case, and an overflow for the water is provided at proper level.

The sale of the engine is exclusively controlled by Thomas C. Maxfield, 120 Liberty street, New York.

Telephone Extension Circuit-Closer.

The accompanying illustrations show the new model Garton-Daniels extension circuit-closer which the Garton-Daniels

TELEPHONE EXTENSION CIRCUIT-CLOSER.

Company, of Keokuk, Iowa, is placing on the market. As is shown in the illustration herewith, this device fastens on the front of the magneto box. The bell clapper strikes the lever when the telephone bell rings, and raises the latch, thus releasing the shutter. This closes the extension

TELEPHONE EXTENSION CIRCUIT-CLOSER.

battery call bell circuit until the shutter is restored by hand. The small switch at the bottom may be used to open the extension circuit, so that the extension bell will not ring when the shutter falls, if so desired.

The Varley Duplex Magnet Company.

The Varley Duplex Magnet Company, of Phillipsdale, R. I., a suburb of Providence, has recently greatly increased its manufacturing facilities. Since the company moved to Phillipsdale, its growing business has required an increase in floor space about every six months, and yet it was not able to satisfy the demand for its product of coil windings and magnets. Within a few weeks the company has leased, for a term of years, a large factory convenient to the American Electrical Works at Phillipsdale, which gives additional room amounting to some 30,000 square feet. The company is thoroughly equipping the building with modern machinery, and installing two gas engines in addition to the steam engine now on the premises.

Mr. Richard Varley, the president of the company, states that for the past six months he has been unable to book half the orders which have been sent in, and it was this condition that compelled the large increase to the company's manufacturing facilities. In addition to this new factory, the American Electrical Works has added to the floor space set aside for the work of the Varley company over 10,000 square feet. The Varley company can now assure its customers that their wants will be promptly attended to, and orders can be filled hereafter without the delay that has been for some time past unavoidable.

The Annual Meeting of the Society for the Promotion of Engineering Education.

The annual meeting of the Society for the Promotion of Engineering Education will be held at Niagara Falls, July 1, 2 and 3. The headquarters will be at the Cataract House. A number of papers have been prepared by men eminent in practical engineering and instructors of different prominent institutions. On Friday, July 3, a joint meeting will be held with the American Institute of Electrical Engineers.

Five hundred grammes of oil (1.1 pounds) produce an energy of one mechanical horse-power. This would equal in continuous effect the efforts of twenty-one men.

The Pennsylvania Railroad tunnel under Baltimore, Md., is to be equipped with fans operated by electricity. Plans have already been submitted to builders for estimates.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

INDIANA TRACTION LINES—Philadelphia and Indiana capitalists have organized the Indiana Union Traction Company, with a capital of $5,000,000, and a bond issue for the same amount. The company will take over the Union Traction Company of Indiana under a lease guaranteeing a rental on a graduated scale. The leased company has $8,500,000 common and $1,000,000 preferred stock. This company recently absorbed the Indianapolis Northern Company, and its system includes about 200 miles. Thomas Dolan, Randall Morgan and J. L. Jones, of Philadelphia, are interested in the company. Mr. George F. McCulloch is president of the corporation.

CHICAGO STREET RAILWAYS LOSE SUIT—The city of Chicago, in the Supreme Court, has been upheld in its contention that it had the right to compel the street railways to lower the tunnels under the Chicago River. The case passed upon was a petition for a mandamus directed to the West Chicago Street Railway Company, which owns the Van Buren street tunnel. The court held that the title to a freehold is not put into issue by the pleadings. The title is admitted to lie with the company. The question then becomes one of obstruction. The Court also held that franchise rights are not interfered with, and can not be, in granting the city the power to order the tunnels lowered.

NEW COLORADO POWER COMPANY—A new company with a capital of $1,000,000 has been incorporated with headquarters in Clear Creek County, Colorado, under the name of the Continental Electric Power and Irrigation Company. The incorporators are: Warren A. Haggott, William P. Clough, Charles S. Birkins and Fred G. Shaffer. The object of the company is to build a large reservoir at the head waters of the middle branch of Clear Creek, near Empire, and to furnish water power for the mines of Clear Creek and Gilpin counties, and to irrigate land in Jefferson, Adams. Weld and a number of other counties. The general offices will be at Idaho Springs.

CHICAGO ELEVATED PLANS—The reorganization committee of the Lake Street Elevated Railroad, Chicago, has secured sufficient securities to warrant its formulating a plan for the financial rehabilitation of the property. The plan, so far as it has been considered, contemplates an assessment of $10 a share on the stock. In connection with the assessment, some securities, either of preferred stock or second mortgage bonds, will be given. About $6,500,000 is to be raised, and financial interests stand ready to underwrite the plan. The greater portion of the money to be raised will go toward the retirement of the first mortgage bond issue. The proceeds of the assessment and stock are to go into the property, providing for improvements and extensions.

INTERSTATE ELECTRIC ROAD—Articles of incorporation have been filed with the Secretary of State at Lansing, Mich., for the Chicago, Michigan & Indiana Electric Railway Company, of Benton Harbor. This company is capitalized at $3,000,000. The plan is to build an electric railway from Chicago to several points in southwestern Michigan. The line will extend from a point on the Inidiana state line to Dowagiac, St. Joseph, Benton Harbor and Pawpaw, with an extension branch to Kalamazoo and Allegan, while the main line will extend along the lake shore into Chicago. The building of the new railroad, which will carry passengers, mail, general freight and fruit, connecting with the Graham & Morton Transportation Company, at St. Joseph, will be commenced on August 1.

MAGNETIC EXPEDITION TO THE POLE—It is announced that the whaling ship Gjoa, with Captain Ammundsen's magnetic North Pole expedition on board, sailed from Christiana, Norway, at midnight, June 17. The expedition will first go to King William Land, on the east coast of Greenland, and will then proceed for Behring Strait. This expedition will undertake a most important task in the interest of the study of terrestrial magnetism. The route to be attempted will take the expedition directly across the Pole, although it has not been announced that the expedition is designed to reach this point. Captain Ammundsen, who is a Norwegian, was the first officer of the Belgica, in Gerlach's Antarctic expedition of 1897-1899. The Gjoa is one of the strongest and best vessels of the Arctic fleet. She can be handled by a small crew, is fitted with an auxiliary petroleum engine, and is equipped for a four years' stay in the Arctic regions.

CALIFORNIA INTERURBAN LINES—It is announced that the $10,000,000 investment of H. E. Huntington in electric interurban lines around Los Angeles, Cal., has proven so profitable that this capitalist has decided to carry out a series of plans which call for an investment of some $30,000,000. Mr. Huntington originally acquired the electric road to Pasadena and the incline property to Mt. Lowe, and built a new line to Long Beach, a short line to Pasadena, with an extension to Alhambra and San Gabriel, and one to Monrovia. These are all first-class double-track standard-gauge road-beds, with the exception of the original Pasadena line, which is to be standardized. Work is now being pushed on similar lines to Whittier, and an extension to Wilmington and San Pedro. For sixty miles around Los Angeles surveyors are locating new lines, and it is stated that roads will soon be built as far north as Santa Barbara, and to San Bernardino and Riverside.

THE DEVELOPMENTS OF RAPID TELEGRAPHY IN GERMANY—A report from Mr. Dean B. Mason, vice and deputy consul-general, Berlin, Germany, states that a new invention relating to rapid telegraphy is undergoing a practical test. The system is known as the Pollak-Virag rapid telegraph, and after a careful examination at the Polytechnic Institute at Charlottenburg, it was shown to the Emperor and Empress of Germany about the middle of last February. It was decided at this time by the chief of the German postal system and other influential persons that the new system would be given a practical test on the line between Berlin and Konigsberg, which is some 710 kilometres (447½ miles) long. The results obtained with the new system, states the consul, are considered most satisfactory, as it has been demonstrated that 40,000 words per hour can be transmitted under the most varying conditions. The Imperial Telegraph Service has decided to investigate the system on the busy line between Berlin and Frankfort. A special writing machine, which is worked in the usual way, perforates a strip of paper which is drawn over a roller under metallic brushes with great rapidity. The interruptions of the current move the membranes of two telephones at the receiving station, which write the messages by means of a small mirror.

ELECTRIC RAILWAYS.

DECATUR, IND.—The council has granted to the Springfield & Fort Wayne Traction Company a franchise through this city. The road must be in operation by December 31, 1904.

DENVER, COL.—The directors of the Cripple Creek & Pike's Peak Railroad have voted to issue $100,000 worth of bonds for the erection of the electric road between Cripple Creek and Pike's Peak.

MARINETTE, WIS.—The Marinette and Menominee street railway companies have consolidated with a capital stock of $560,000 The lines may be extended to Escanaba on the north, and to Green Bay on the south.

NEWBURGH, N. Y.—It is now said that the proposed Albany and Catskill road will be completed next winter or early in the spring of 1904. The road will be constructed at a cost of $1,250,000, and will cover thirty-five miles.

McKEESPORT, PA.—It is stated that an electric railroad will shortly be constructed from McKeesport to Irwin. The road will be eight miles in length, and something like $200,000 will be expended this summer in its construction.

DETROIT, MICH.—Arthur D. Prosser has filed in the office of the Secretary of State articles of incorporation of the Huron &

Michigan Railway Company, organized with $2,300,000 capital to build an electric railroad from Grand Rapids to Saginaw.

JERSEY CITY, N. J.—At a special meeting of the stockholders of the Havana Electric Railway Company it was voted to issue $250,000 bonds for construction, equipment and improvement purposes. This is a part of the $2,500,000 bonded indebtedness that the company is authorized to incur.

MILWAUKEE, WIS.—The Sheboygan & Calumet Electric Company has been organized with a capital of $500,000, by Sheboygan men, for the purpose of building an electric road to Howards Grove, Franklin, Kiel, New Holstein and Chilton. At Chilton it will connect with the proposed line from Fond du Lac.

INDIANAPOLIS, IND.—In the office of the county recorder a mortgage has been filed by the Indianapolis & Northwestern Traction Company to the Knickerbocker Trust Company, of New York city, to authorize the issuing of $3,000,000 in bonds by the traction company. Five per cent gold bonds are to be issued.

ALBANY, N. Y.—The Barney Traction Company, which proposes to build a street railway from the Susquehanna & Buffalo Junction to Salamanca and West Salamanca, Cattaraugus County, has been granted authority to construct the line by the State Railroad Commission. The company has a capital of $50,000.

DES MOINES, IOWA—M. E. Springer, of this city, is promoting a plan to build an electric railway from Albia to Buxton, Heitman, Hocking, Hilton and Hynes. The intention is to ultimately extend the lines to Ottumwa, Centerville and Des Moines, touching such points as Tracey, Harvey, Bussey and Knoxville, on the way to this city.

LIMA, OHIO—The Western Ohio Traction Company's line has been completed between Lima and Pipua. With the completion of the electric line it is possible for the electric cars to run through from Cincinnati to Toledo, the Cincinnati, Dayton & Toledo forming the southern connection, and the Toledo, Bowling Green & Southern the connection at the Toledo end.

HOUSTON, TEX.—A local organization has been formed here, headed by W. E. Scott, to build an electric line from Houston to Galveston. The city council has been asked for the right of way through Houston. The enterprise is to be backed by an English syndicate which has pledged $1,000,000. The company is to build its own bridge across the bay, and will do a freight as well as a passenger business.

BIRMINGHAM, ALA.—The Mansfield Railway, Light and Power Company, which purchased the Citizens' Railway, Light and Power Company's plant and property in this city, will expend the sum of $250,000 in improving the local city car lines and Mansfield-Shelby interurban trolley line. The improvements to the property will begin at once, and it is expected that they will be finished within eighteen months or two years at the most. The company has increased its capital stock from $400,000 to $1,000,000.

DAYTON, OHIO—The stockholders and directors of the Greenville & Union City Traction Company, and the Union City, Winchester & Muncie Traction Company, have completed a consolidation of the two companies under the name of the Dayton & Muncie Traction Company, with a capital stock of $800,000. They also authorized a bond issue of $800,000. The following officers were elected: President, J. E. Lowes; vice-president, A. Newsalt; secretary, J. E. Feight; treasurer, W. B. Gebhart. The entire road will be completed and in operation January 1, 1904, which will make a through line to Indianapolis by way of the Dayton & Northern Traction Company.

HARTFORD, CT.—The Senate has passed a resolution amending the charter of the Willimantic & Southbridge Street Railway Company. The measure authorizes the corporation to increase its capital stock from $50,000 to $150,000. The company proposes to construct an interstate railway between Willimantic, Ct., and Southbridge, Mass. Its Connecticut charter gives the company authority to operate in the towns of Windham, Ashford, Eastford and Chaplin. The Voluntown & Jewett City Street Railway Company has also been granted a charter. The company, authorized to issue capital stock to a maximum of $500,000, is granted a franchise in the towns of Voluntown and Griswold and the borough of Jewett City. The incorporators are John N. Lewis, George T. Briggs and Ezra Briggs.

TELEPHONE AND TELEGRAPH.

ALBANY, KY.—The Gainesboro Telephone Company will put in an exchange in this village.

LONDON, OHIO—The London Home Telephone Company has increased its capital stock to $200,000.

RALEIGH, N. C.—The Marshville Telephone Company, of Union County, has been chartered with a capital of $14,500.

NEW HAVEN, CT.—The Southern New England Telephone Company is about to extend its lines to White Hills and Shelton.

FREEPORT, OHIO—The Belmont Telephone Company has decided to build a line across the country from St. Clairsville to Maynard.

PAVILION, N. Y.—The Bell Telephone Company has completed the construction of a rural line from Pavilion, through Covington, to Peoria.

PEKIN, ILL.—At a meeting of the stockholders of the Citizens' Telephone Company, the capital stock was increased from $40,000 to $200,000.

SHELBYVILLE, IND.—A new telephone company has been organized at Portland, and will operate in a number of counties, including Shelby.

DURANGO, COL.—The Colorado Telephone Company has purchased a site in Trinidad and will erect an exchange and central office building in that city.

FLEMINGTON, N. J.—The Farmers and Merchants' Telegraph and Telephone Company, of Sergeantville, has increased its capital stock from $10,000 to $20,000.

WINCHESTER, IND.—The Winchester and Eastern Indiana Telephone companies have been consolidated. Many improvements will be made to the present plants.

CHATTANOOGA, TENN.—The East Tennessee Telephone Company will make extensive improvements to its plant. New switchboards will be installed at a cost of $10,000.

SCOTTSBURG, IND.—The Jefferson Telephone Company has been organized at Madison to operate a telephone line in Jefferson, Clark, Scott, Jennings, Switzerland and Ripley counties.

GIRARDVILLE, PA.—The Carbon County Telephone Company will build a trunk line between Tamaqua and Mauch Chunk, connecting with the United lines at Tamaqua and the Consolidated lines at the latter place.

ROCK DALE, WIS.—It is stated that another telephone line will shortly be constructed between Rock Dale and Utica, connecting both places with Madison, Cambridge, Deerfield, Edgerton, Stoughton, Janesville and Oregon.

MERIDEN, CT.—The work of constructing a new system of aerial cable and the rebuilding of telephone lines in this city by the Southern New England Telephone Company will cost the company in the neighborhood of $10,000.

DAYTON, OHIO—The Montgomery County Telephone Company, of this city, has been incorporated at Columbus with a capital stock of $20,000, by Leopold Rauh, Harry C. Kiefaber, John T. Barlow, J. D. Artz and Edward Candy.

UNIONTOWN, PA.—P. A. Johns has constructed two telephone lines, one from Pritts to Indian Head, to connect with the Tri-State, and the other from Pritts to Trent, to connect with the Somerset County Telephone Company's line.

ALBANY, N. Y.—The Commercial Telephone Company has been merged with the Columbia Telephone Company, of Hudson. The capital is $50,000, and the directors are Edward Charles Getty, of Hudson; R. G. Foster, of New Hartford, Ct., and Benjamin F. Case, of Canton Center, Ct.

BARBOURVILLE, KY.—A new telephone company has been organized at this place, which is known as the Hyden Telephone Company. This concern intends to put in a line from Manchester, Clay County, to Hyden, Leslie County. The line will be thirty-two miles long, and will run in an easterly direction from Manchester.

ELECTRICAL SECURITIES.

The week just passed shows little progress in stock market developments as far as any definite advance in the price of securities is concerned. Following the rally of the early part of the week there was a rather disastrous break, which was protracted until any advance which had been made was practically discounted. It would seem from the opinions which are freely voiced, that financial people were in for a period of dulness, and with the approach of the hot months of the summer, the interest of the speculating public is not likely to become a strong factor in shaping the course of the market. The monetary situation has seen no important development, and industrial conditions, on the whole, show nothing of importance which would tend to stimulate a keener interest in speculation.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JUNE 20.

New York:	*Closing.*
Brooklyn Rapid Transit	57
Consolidated Gas	194
General Electric	177½
Kings County Electric	200
Manhattan Elevated	136
Metropolitan Street Railway	124¼
New York & New Jersey Telephone	161
Westinghouse Manufacturing Company	198

The Westinghouse Electric and Manufacturing Company has declared a dividend of ⅞ per cent upon the preferred stock, out of the earnings from April 1, 1903, until May 15, 1903, and one of 1¼ per cent out of the earnings of the company from May 15, 1903, to July 1, 1903. A dividend of 1¼ per cent has been announced on the assenting and non-assenting stocks. All are payable July 10.

Boston:	*Closing.*
American Telephone and Telegraph	142
Edison Electric Illuminating	240
Massachusetts Electric	83
New England Telephone	135
Western Telephone & Telegraph preferred	92

The earnings of the various subcompanies of the Massachusetts Electric companies are said to be showing an average weekly increase in gross earnings of 7 to 10 per cent, although both classes of stock have declined from 12 to 15 per cent from the highest of the year, and are much below the lowest level reached last year.

Philadelphia:	*Closing.*
Electric Company of America	8½
Electric Storage Battery common	63
Electric Storage Battery preferred	63
Philadelphia Electric	6¼
Union Traction	45
United Gas Improvement	88½

Chicago:	*Closing.*
Chicago Telephone	132½
Chicago Edison Light	150
Metropolitan Elevated preferred	66
National Carbon common	23½
National Carbon preferred	95
Union Traction common	3½
Union Traction preferred	32

Notice is given by the protective committee to the holders of the securities of the Chicago Union Traction Company, the North Chicago Street Railroad Company, and the West Chicago Street Railroad Company that the time for depositing their holdings has been extended for sixty days from June 15.

PERSONAL MENTION.

MR. CHARLES A. MOORE, of Manning, Maxwell & Moore, returned to the city recently after a winter's rest with his family in Palestine.

DR. J. MOUNT BLEYER, of New York city, is contributing a series of articles on "Light" in the current numbers of the *Medical Examiner and Practitioner*. Dr. Bleyer has done some remarkable research work in phototherapeutics and electrotherapeutics.

MR. MARSDEN J. PERRY, of Providence, the president and general manager of the Narragansett Electric Lighting Company, was a New York visitor last week. Mr. A. B. Lyle, assistant general manager, and Mr. W. C. Woodward, electrical engineer of the same company, came with Mr. Perry.

MR. CALVIN W. RICE, vice-president of the Nernst Lamp Company, is on his way to Europe, having been booked for passage on the Friedrich der Grosse, which sailed on June 25. Mr. Rice has had several years of hard business campaigning, and will now take a well-earned rest. He intends to tour through a number of countries during his vacation.

PROFESSOR S. W. PARR, of the University of Illinois, has succeeded in devising a method for the determination of the amount of sulphur occurring in coal. Professor Parr has also discovered a means of arriving at the total amount of carbon in coal and other combustibles. This is a matter of the highest importance to operating engineers.

MR. O. E. OSTHOFF, who has for some time been engineer of the Chicago office of the Electric Storage Battery Company, of Philadelphia, has joined forces with H. M. Byllesby in the business of consulting engineer, in Chicago, Ill. Mr. Osthoff's headquarters will be at Chicago, where his long residence and great activity have brought to him a large number of friends and acquaintances.

MR. H. H. VREELAND, president of the Interborough Street Railway Company, New York city, is contemplating a trip to London in July. At this time it is expected that Mr. Vreeland will respond to an invitation received from the secretary of the Royal Commission on London Traffic, Mr. Lyden McCassey, to address that board as an expert in city railway practice. On Monday evening, President Vreeland was tendered a banquet at the Hotel Savoy by the employés of his system.

MR. THOMAS LOWRY, Mr. W. A. Read, Mr. W. H. Goadby, Mr. Clinton Morrison, Mr. John Keane, Mr. C. J. Goodrich and Mr. Horace Lowry were elected to the board of directors at the annual meeting of the Twin City Rapid Transit Company. Mr. J. Kennedy Todd and Mr. A. E. Ames were not reelected. The present arrangement of directors now makes it possible to have a quorum either in Minneapolis or New York city. The directors reelected the old officers.

MR. L. J. CALLANAN, owner of the schooner yacht Estelle which capsized on Long Island Sound recently, has written the following communication to the New York *Times:* ". . . It was with great pleasure we saw the steam yacht Zara coming directly for us as fast as she could come. I think she was alongside of us in not more than five minutes after the accident occurred. Her boat was lowered at once and we were taken off the side of the Estelle, which was about one-third out of the water. My guests and myself were received by Commodore Shippy and treated in the most hospitable manner, all our wants being attended to promptly." Mr. Callanan concludes: "My most sincere thanks are tendered to the boats which came so promptly to our assistance, and to Commodore Shippy, his guests, and the officers and crew of the Zara, who vied with each other in their efforts to satisfy our every want."

MR. H. M. BYLLESBY has just leased large and commodious quarters in the New York Life Building, Chicago, Ill., and expects to occupy these on July 1 of this year. Mr. Byllesby has been a prominent figure in the electrical field for a number of years, and is at present the dominant factor in a rapidly increasing consulting engineering business. At this time Mr. Byllesby has a prominent connection with a number of interests, a few of which may be enumerated as follows: Consulting engineer of the Hazleton & Wilkesbarre Third-Rail System Electric Railroad; vice-president and engineer of the Zanesville Railway, Light and Power Company, of Zanesville (this plant is just putting up an extensive water power and steam turbine station, enlarging the system, and rebuilding the track); engineer representing the financial interests of the Columbus, Delaware & Marion Railway Company now under construction from Columbus, Ohio, to Marion, Ohio, with a total trackage of sixty-two miles; president and general manager of the Mansfield Railway, Light and Power Company, of Mansfield, Ohio, including the Mansfield-Shelby-Interurban; director and consulting engineer of the Freeport Railway, Light and Power Company, of Freeport, Ill.; president and general manager of the Venice & Granite City Electric and Power Company of Illinois; vice-president and general manager of the Belleville Gas and Electric Company, of Belleville, Ill.; vice-president and general manager of the Centralia Gas and Electric Company, of Centralia, Ill.; president of the Enid Electric and Gas Company, of Enid, Oklahoma Territory; consulting engineer of the Shreveport Gas and Electric Company, of Shreveport, Iowa. Mr. Byllesby has gathered about him a strong staff of engineers and operating men, and the extension of his business has made it necessary to secure the headquarters mentioned above.

INDUSTRIAL ITEMS.

THE GOLD CAR HEATING AND LIGHTING COMPANY, New York city, has brought suit in the United States Circuit Court, Northern District of Illinois, at Chicago, Ill., against Mr. Egbert H. Gold for alleged infringement of United States Letters Patent No. 388,772, for car-heating apparatus.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, has issued a new catalogue descriptive of asbestos roofing. This lists a number of standard applications of asbestos, as well as special applications, in various parts of the country. This catalogue will be sent on request.

THE C. W. HUNT COMPANY, West New Brighton, S. I., N. Y., in pamphlet No. 034 gives a very complete list of industrial railways for all kinds of service. This leaflet is well illustrated, and will be read with much interest by any one contemplating radical changes from old-style methods of handling material in any kind of a factory.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., has issued two handsome bulletins descriptive, respectively, of sewing-machine motor equipments and automatic circuit-breakers for direct current. Each of these bulletins is illustrated by handsome half-tone engravings printed on heavy coated paper, and the illustrations are supplemented by accurate descriptions of each piece of apparatus.

THE DULUTH STOKER COMPANY, Duluth, Minn., has just closed a contract with the American Steel and Wire Company for eight Duluth stokers of 320 horse-power each. It is the intention of the company to manufacture these stokers in Chicago. At the present time the company has installations going on at Detroit, Mich.; South Chicago, Ill.; Cleveland, Ohio.; Madison, Me., and West Superior, Wis.

J. JONES & SON, 64 Cortlandt street, New York city, will be pleased to send on request a new booklet descriptive of "Perfection" battery fans. While the opinion prevails to a considerable extent that battery fans are more or less toys, this apparatus is claimed to be built along the same lines as the larger sizes of fan motors. The fan blades are well balanced, the guard is a heavy one, and the battery is guaranteed to run, with ordinary use, for at least 250 hours.

JOHNSON & MORTON, Incorporated, electrical engineers and manufacturers, 44 Whitesboro street, Utica, N. Y., are specialists in the manufacture of junction boxes, panel-boards, switchboards and switches. By confining their product to these lines these manufacturers feel that they are bringing before the market a material that possesses features of great merit and advantage. Special tools have been designed, and a most thorough concentration along this line has led to the production of exclusive samples. The company will be pleased to send its illustrated literature on request.

THE CENTURY TELEPHONE CONSTRUCTION COMPANY, Buffalo, N. Y., is actively engaged in the construction of the Le Roy Telephone Company's plant, at Le Roy, N. Y. There is being installed there a 200-line common battery light signal switchboard. The power for this exchange is furnished by storage batteries which are charged by motor-generators. The company is about to complete the building and installation of the central station apparatus for the Avon Telephone Company, Avon, N. Y. This equipment is common battery, with visual target line signals. The equipment is one of the latest developments in telephone apparatus.

THE LAWRENCE-HALL ELECTRIC COMPANY, Incorporated, 213 West Fourth street, Cincinnati, Ohio, which succeeded the Hall Electrical Supply Company on March 2, 1903, is making rapid advances in the development of new business and in the increase of old lines. The company makes a specialty of prompt shipments of high-grade goods. Mr. Frank D. Lawrence, formerly president of the Standard Electric Company, is president and treasurer, and Mr. William Albert Hall, formerly president of the Hall Electrical Supply Company, is vice-president and secretary.

WESTINGHOUSE, CHURCH, KERR & COMPANY have recently sold additional train lighting equipments to the Chicago, Milwaukee & St. Paul and the Northern Pacific Railways Company, for service on their special limited trains. The outfit consists of a twenty-five or thirty-horse-power Westinghouse standard vertical single-acting engine, direct-connected to a direct-current generator of corresponding capacity. The units are compact and are located in the front part of the baggage car, which location is favorable for supplying high-pressure steam directly from the locomotive boiler through flexible piping. The direct-connected steam-driven unit possesses many advantages for train lighting service, and the majority of troubles, incident to the use of other types of apparatus for this service, are avoided. The system is now in use on a large number of roads in this country, including the Chicago & North Western, Union Pacific, Lake Shore & Michigan Southern, and Duluth South Shore & Atlantic.

THE NATIONAL WIRE CORPORATION, New Haven, Ct., has recently entered the field for the manufacture of galvanized telephone and telegraph wire, cable armor wire, wire rope and wire strand. This company has already been successful in securing some of the largest contracts for this class of material, and is equipped with the latest and most improved machinery for this kind of work. The company is owned and operated by the National Steel and Wire Company, and is the largest constituent company under its control. The DeKalb Fence Company and the Union Fence Company, of DeKalb, Ill.; the Kansas Steel and Wire Works, of Kansas City, Mo.; the Pacific Steel and Wire Company, of Oakland, Cal., and the National Steel Foundry Company, of New Haven, Ct., are all allied through the ownership and control of the National Steel and Wire Company. The various mills in this group produce everything in the wire line, from rods to the finest grades of wire rope and iron electrical wires, including also many styles of woven wire fence and other wire specialties. The National Wire Corporation was originally formed in New Haven in the spring of 1899, but its works was entirely destroyed by fire, February 3, 1901. Since that time the works has been rebuilt on a larger scale. A booklet which the company has recently issued, describing its methods and the art of making high-grade telephone and telegraph wires, will be sent on request to any one interested. The company is managed by some of the oldest and most experienced men in the wire business, who have had connections with the most prominent wire producers of the country. Mr. Everett B. Webster is managing director, and Mr. Walter H. Seaver is sales manager.

LEGAL NOTE.

GENERAL ELECTRIC COMPANY SUED—Despatches from Boston announce that S. F. Van Choate has entered suit in the United States Circuit Court against the General Electric Company, for an alleged infringement of patents. The complainant sets the damage at $50,000,000. Mr. Van Choate alleges that the General Electric Company, and each electric railway company in the United States that has been in operation before October 16, 1900, have infringed upon his inventions in the use of large multipolar dynamos, and controlling switches on the platforms of the cars for varying the resistance of the electric currents through or in the coils of the motors. It is stated that the company does not regard the suit seriously.

OBITUARY NOTICES.

MRS. LUCY D. POPE, wife of Henry W. Pope, late acting general manager of the Bell Telephone Company, of Buffalo, N. Y., died at Buffalo, June 21. The interment was at Great Barrington, Mass.

MR. W. VAN BENTHUYSEN, editorial manager of the New York *World*, died at his home, 120 Buckingham road, Brooklyn, at four o'clock Friday morning, June 19. Mr. Van Benthuysen had been in declining health for over a year, but at one time it appeared that he would ultimately recover, and he had resumed work in the *World* office. Four weeks ago, however, he suffered a relapse. Mr. Van Benthuysen was born near Drakeville, Davis County, Iowa, on December 1, 1855. His father, Judge William Van Benthuysen, of Bloomfield, Iowa, is still living. Mr. Van Benthuysen, has had a brilliant career, starting in California in 1873 as a compositor. He was the owner of several profitable newspapers throughout the country, and was editor of the Leavenworth (Kan.) *Press* and the Leavenworth *Times*, and managing editor of the Chicago *Tribune*, where he remained for some eight years. He came to New York in 1898 to take the position of editorial manager of the *World*. Mr. Van Benthuysen is survived by a widow, three sons and two daughters.

EXPORT AND DOMESTIC NUMBER

ELECTRICAL REVIEW

VOL. XLII—No. 7.
Copyright, 1903, by ELECTRICAL REVIEW PUB. CO.

NEW YORK, SATURDAY, FEBRUARY 14, 1903.

TEN CENTS A COPY.
THREE DOLLARS A YEAR.
FIVE DOLLARS FOREIGN.

THE PHOENIX GLASS CO.
Manufacturers of
Gas and Electric Globes, Shades, Etc.
Send for our LATEST CATALOGUE Now Ready
PITTSBURGH
NEW YORK
CHICAGO

"Phono-Electric" Wire
"IT'S TOUGH"
Will give a security and permanence to your trolley, telephone or telegraph lines.

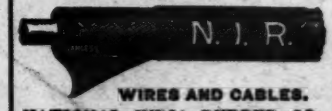
BRIDGEPORT BRASS CO.
19 Murray Street New York

AMERICA'S LARGEST ELECTRICAL SUPPLY HOUSE

ELECTRIC APPLIANCE COMPANY, NINETY-TWO & NINETY-FOUR WEST VAN BUREN STREET, CHICAGO

THE BRISTOL CO.
WATERBURY, CT.
Recording Voltmeters
Recording Amperometers
Recording Wattmeters
Recording Pressure Gauges
Recording Thermometers
PAY FOR THEMSELVES
SEND FOR CATALOGUE

WILLARD L. CANDEE, H. DURANT CHEEVER, } Mgrs.
GEO. T. MANSON, Gen. Supt. W. H. HODGINS, Secy.
1889 PARIS EXPOSITION MEDAL FOR RUBBER INSULATION
OKONITE
TRADE MARK
1893 WORLD'S FAIR MEDAL FOR RUBBER INSULATION
THE STANDARD FOR RUBBER INSULATION.
Sole Manufacturers of OKONITE WIRES, OKONITE TAPE, MANSON TAPE, CANDEE WEATHERPROOF WIRES. Write for Prices.
THE OKONITE CO., Ltd., 253 Broadway, New York.



WIRES AND CABLES.
NATIONAL INDIA RUBBER CO.
Factory and General Offices:
BRISTOL, R. I.

SCHLESINGER & MEARS
220 BROADWAY, N. Y. CITY
NEW ENGLAND ELECTRIC MFG. CO.
SOCKETS, RECEPTACLES, CUT-OUTS
HAINES & NOYES CO., Chicago, Ill., Telephones, Complete Line.
"S. & M." Incandescent Lamps. Porcelain Insulators, Cleats and Special Porcelains. Semi-Porcelain Tubes.

THE NATIONAL CONDUIT & CABLE CO.
Manufacturers of BARE COPPER WIRE AND CABLE,
PAPER INSULATED CABLES FOR TELEPHONE, TELEGRAPH, ELECTRIC LIGHT AND POWER.
CEMENT LINED PIPE FOR CONDUITS.
Executive Offices, Times Building, NEW YORK, N. Y.

WARREN ELECTRIC AND SPECIALTY CO., WARREN, O., U.S.A. Manufacturers
—ALL KINDS OF—
INCANDESCENT LAMPS
INCLUDING MINIATURES

MONTAUK FIRE DETECTING WIRE CO.
Only Fire Detective Wire in the World. 100 BROADWAY, NEW YORK CITY.
"Approved by the New York Board of Fire Underwriters, February 20, 1901."

AMERICAN ELECTRICAL WORKS
BARE and INSULATED ELECTRIC WIRE
MAIN OFFICE AND FACTORIES • PHILLIPSDALE, R. I.

STANDARD UNDERGROUND CABLE CO.,
FIBER PAPER RUBBER **ELECTRIC CABLES,** FOR ALL CLASSES OF SERVICE
HIGH-GRADE BARE RUBBER COVERED AND WEATHERPROOF **WIRES.** Telephone, Telegraph, Electric Light and Power.
Westinghouse Bldg., Pittsburgh, Pa.; 16 Liberty St., New York; 1225 Betz Bldg., Philadelphia, Pa.; 322 The Rookery, Chicago, Ill.; Mills Bldg., San Francisco, Cal.; 101 Milk Street, Boston, Mass.

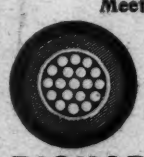
ALL OUR WIRES—NEW CODE STANDARD
NEW YORK INSULATED WIRE COMPANY
Main Office: 114, 116 and 118 Liberty St., New York Branches: CHICAGO, 192 Desplaines St.; BOSTON, 7 Otis St.; SAN FRANCISCO, 33 Second St.

THOUSANDS IN USE.
Bipolar and Multipolar Motors from 1-6 to 50 H.-P. Dynamos from 10 lights to 700. We sell or rent. Good profits for Agents.
THE HOBART ELEC. MFG. CO. TROY, OHIO.

KEYSTONE MEASURING INSTRUMENTS **I-T-E** CIRCUIT BREAKERS

FLEXDUCT
The Superior Flexible Conduit for Interior Wiring
OSBURN FLEXIBLE CONDUIT CO.
21 Park Row :: New York City

Stanley Electric
THE SC SYSTEM
Manufacturing Co.

Bishop Wires and Cables
Meeting the most trying conditions a specialty

All kinds of FLEXIBLE CABLES. For Controlling, for Electric Lights, and for Annunciators in ELEVATORS
Also for Theatre and other trying work
BISHOP GUTTA-PERCHA COMPANY
422-426 EAST 25TH ST., NEW YORK

SIMPLEX WIRES & CABLES
For Underground, Submarine, Line and Inside Construction
THE SIMPLEX ELECTRICAL CO.
110 State St. BOSTON 1137 Monadnock Blk. CHICAGO

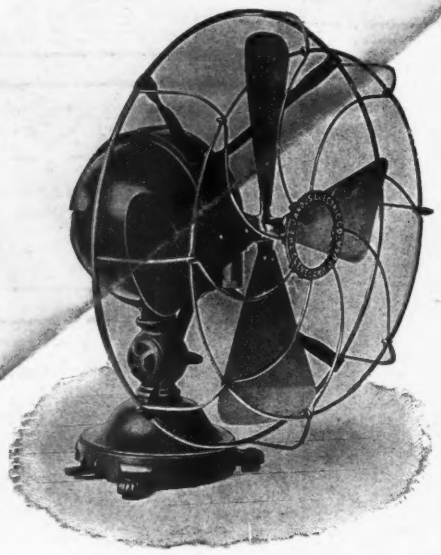
INDEX TO ADVERTISERS PAGE 36

CLASSIFIED INDEX PAGE 48

1903 JANDUS 1903
ELECTRIC FANS

Alternating and Direct Current

SIZES: 12-INCH, 15-INCH AND 16-INCH



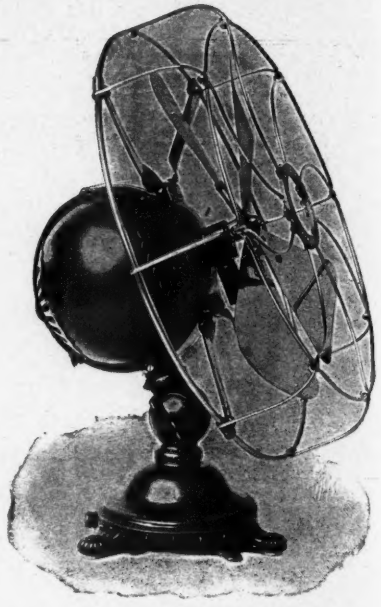
Direct-Current Fan

A COMBINATION

Performing the Functions of a

DESK FAN,
BRACKET FAN,
TRUNNION FAN,
BRACKET
TRUNNION FAN

"Multum in Parvo"

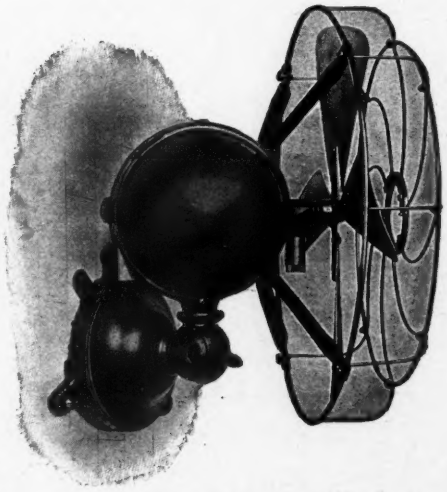


Alternating-Current Fan

Last Season's weather was the worst Fan weather in years, but

OUR SALES
QUADRUPLED

Ask the dealers who handled Jandus Fans why



Used as a Bracket Fan

Handsome in Appearance

Enclosed and Dust Proof

Fine Mechanical Work

High Electrical Efficiency

Anti-Friction Thrust Bearings, Etc., Etc.

THE JANDUS ELECTRIC COMPANY

Manufacturers of Enclosed Arc Lamps, Electric Motors, Etc.

CLEVELAND, OHIO

115 Broadway
NEW YORK

Monadnock B'ld'g
CHICAGO

Real Estate Trust B'ld'g
PHILADELPHIA

D. & W. SAFETY DEVICES

TYPE C INDICATING FUSE BEFORE BLOWING

TYPE C INDICATING FUSE AFTER BLOWING

PLUG CUT-OUTS. STREET CAR MOTOR CUT-OUTS. DUPLEX FEEDER CUT-OUTS ENTRANCE CUT-OUTS. TRANSFORMER AND JUNCTION CUT-OUTS. STANDARD CUT-OUTS. RENEWABLE FUSE PLUGS. SERVICE SWITCHES AND BOXES. TELEPHONE, TELEGRAPH AND FIRE ALARM PROTECTORS

Send for New D. & W. Price List No. 9

OKONITE IT NEVER DISAPPOINTS

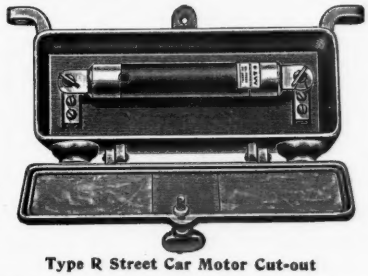
Central Electric Company,

SALES AGENTS

264-266-268-270 FIFTH AVENUE, CHICAGO

OKONITE IT NEVER DISAPPOINTS

ELECTRIC CAR SERVICE



Type R Street Car Motor Cut-out

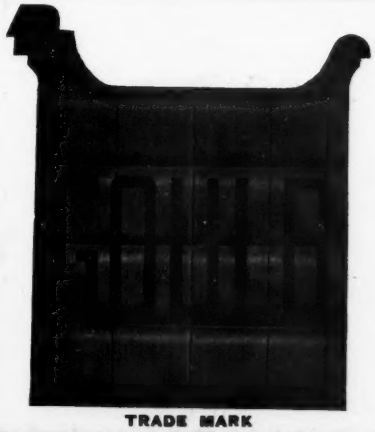
Protect Your MOTORS By Using "D. & W." Enclosed Indicating Fuses

D. & W. FUSE CO., Providence, R. I.

A. HALL BERRY, New York Representative, 100 William Street

OFFICES

BOSTON—Pettingell-Andrews Co
NEW YORK—Western Electric Co.
ST. LOUIS—Western Electric Co.
PHILADELPHIA—Western Electric Co.
SAN FRANCISCO—California Electrical Works
CHICAGO—Central Electric Co.



TRADE MARK

Gould Storage Battery Co.

NEW YORK

Storage Battery Installations

for Railroad Regulating, Lighting, Power and Isolated Plants. GOULD C, E-M-F BOOSTER SYSTEMS

SALES OFFICES

Boston, 53 State Street Chicago, Rookery Building New York, 25 West 33d Street
Century Electric Company, San Francisco, Cal. Pittsburg Engineering Company, Pittsburg, Pa.

WORKS: DEPEW, N. Y.

Bulletin No. 2, describing "GOULD BOOSTER SYSTEMS," on application

ARE YOU AWARE THAT

J. H. Bunnell & Co.

20 PARK PLACE, NEW YORK

are PIONEER Manufacturers of

DRY BATTERIES

Try a sample order "Mascot" or "Jove" Dry Cells. Our NEW JAPANNED and NICKEL-PLATED

"BEEKO" BOX BELLS

are above all others in appearance and quality and below all others in price

Our **SUNSHINE LAMPS** are winners

We can supply your wants for

CABLES, WIRES, INSULATORS, Etc.,

with best grades at lowest prices. GIVE US A CHANCE TO PROVE IT

The name "BUNNELL" on telegraph or other electrical apparatus is positive assurance that it is the best

J. H. Bunnell & Co.

Manufacturers, Importers and Dealers in Telegraph, Telephone, Railway and Electric Lighting Supplies, Instruments, Batteries, Insulated Wires and Line Equipment

20 PARK PLACE, NEW YORK - - - P. O. BOX 1286

FACTORIES: 5 to 15 Sullivan Street, 110 to 120 Beekman Street, New York, and Milford, Conn.

Announcement

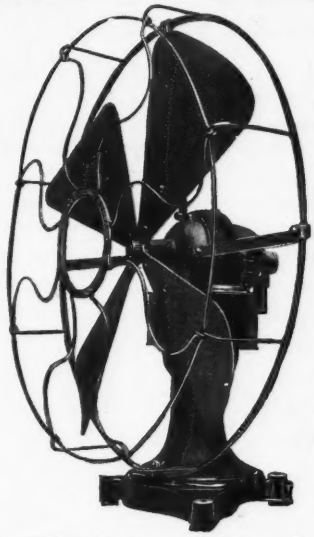
Our factory is in operation. We are now making electric light carbons. We are rapidly equipping the other departments so that by March, in addition to Arc Light Carbons, we will be making Electrolytic Carbons, Battery Carbons, Dry Batteries, Carbon Brushes, Telephone Carbons and Carbon Specialties. Don't fail to get our prices before making contracts . . . . . .

The **Dickey Sutton Carbon Co.**
Lancaster, Ohio

Western Electric Company

Chicago • Saint Louis • Philadelphia • New York

1903 FAN MOTORS



Ceiling Bracket and Desk Styles

Self-Oiling Bearings

Superior Designs and Workmanship

Larger and Better Stock Than Ever

Illustrated Catalogue Sent on Request

Nernst Lamps

A FULL LINE CARRIED IN STOCK BY

The New England Engineering Co.

WATERBURY, CONN.

☞ Send for Catalogue

Best and Cheapest Line of

Electric Novelties

on the Market

WRITE FOR PRICES AND TERMS

ELECTRIC CONTRACT CO.

154 Lake St., Chicago 53 Maiden Lane, N. Y.

H.-U. ACCUMULATORS

For electric light and railway, central and sub-stations, power stations, telephone, telegraph, railway car lighting and all other purposes to which storage batteries are applicable

Helios-Upton Company

Factory and Sales Room - - - - - - 222 Fullerton Avenue

CHICAGO, ILL.

National Storage Batteries

OF HIGHEST GRADE FOR

Railway Power Plants Central Stations, Automobiles, etc.

RENEWALS FOR BATTERIES OF ANY MAKE

DETAILS ON APPLICATION

NATIONAL BATTERY CO.

368-382 Massachusetts Ave., BUFFALO, N. Y.

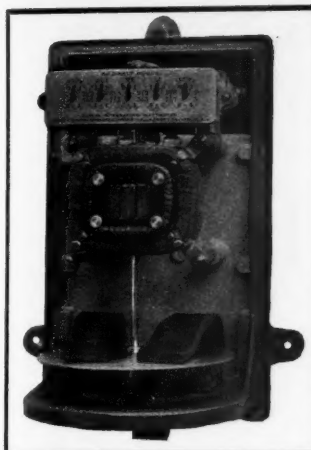
SIEGRIST SYSTEM,

AUTOMATIC LUBRICATION----PATENTED.

THE GREAT OIL AND LABOR SAVER. PAYS A BIG INTEREST ON THE INVESTMENT.
NOT AFFECTED BY HEAT OR COLD. PLENTY OF OIL UNDER ALL CONDITIONS.

OWNERS AND CONSULTING ENGINEERS ARE INSTALLING IT ALL OVER THE WORLD.

A LIST OF USERS FURNISHED BY ADDRESSING SIEGRIST LUBRICATOR CO., ST. LOUIS, MO., U. S. A.



Duncan Integrating Wattmeter

FOR DIRECT-CURRENT LIGHTING
AND POWER SERVICE

The Most Accurate and Up-To-Date Meter upon the Market

DUST PROOF NO CONSTANTS SENSITIVE GOOD MAGNETS

Duncan Electric Manufacturing Co.

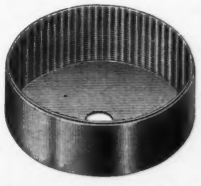
Lafayette, Indiana

INSULATED WITH
SHEET MICA

"DIAMOND H"

INDICATING OR NON-INDICATING
AS DESIRED
EASILY INSTALLED BY REMOVING
THE DIAL AS ABOVE

THE COVER LINER
ONE PIECE
AND CANNOT BE
PULLED OUT OF
THE COVER

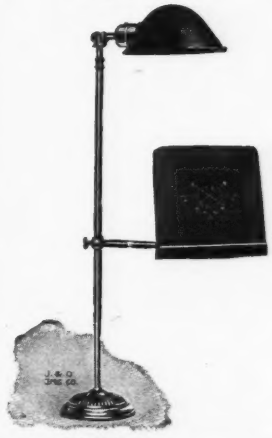


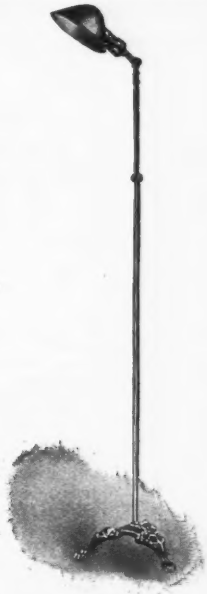
THE HART MFG. CO.

HARTFORD, CONN.

A Combination Hard to Beat

A Copyholder and Typewriter Lamp Combined





No. 1

Throws a fine light over copy and keyboard of machine. Thoroughly adjustable, can be raised, lowered or angled as desired. Weight, 5 pounds; height, 25 inches; diameter of base, 5 inches. Furnished in oxidized copper, oxidized brass, nickel-plate or polished brass.

Price—Complete with shade, 2 yds. of cord and socket, ready for use, $6.00

No. 50

A lamp for general use at the easy chair, bed or sewing table. Fancy enameled iron base and polished brass standard. Can be raised or lowered at will. Height of lamp, 3 feet. Height of lamp when raised, 5 feet. Has half ball aluminum shade with joint.

Price of lamp complete, $5.50

DEALERS WRITE FOR DISCOUNT

Pacific Electric Co.

LA CROSSE, WIS.

THE REUTERDAHL STORAGE BATTERY

OUR

Electrochemically Formed Plate

IS CONSTRUCTED IN ACCORDANCE WITH THE MOST ADVANCED IDEAS OF MODERN ELECTROCHEMISTRY

WRITE FOR BULLETIN G

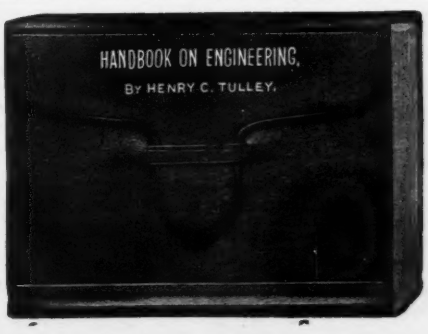
REUTERDAHL ELECTRIC CO. PROVIDENCE R.I.

WESTERN OFFICE. 1504 MONADNOCK BLOCK. CHICAGO ILL.

THE BEST AID TO SUCCESS

An Encyclopedia of information, and in itself the most complete Library on Engineering practice ever published for the use of

STEAM USERS, ENGINEERS ELECTRICIANS, FIREMEN AND MACHINISTS



This Work Contains

Over 900 pages and 400 fine illustrations. Every branch of Engineering treated in a scientific and comprehensive manner. In it will be found a solution of the many knotty problems met in daily practice.

It is thoroughly reliable and practical; it is not only a guide, but a teacher.

As a reference and text-book it is the fullest, latest, and best authority on the subjects treated. It extends to details not found elsewhere.

Indorsed by the foremost practical men in the world.

Handsomely bound in leather and gilt. Pocket-book form.

The 3d edition now ready

Sent anywhere on receipt of price, $3.50, money back if not satisfactory.

Send for 42-page illustrated circular

HENRY C. TULLEY & CO., 910 Wainwright Building, ST. LOUIS, MO., U. S. A.

"The How and Why of Electricity"

By CHARLES TRIPLER CHILD, Late Technical Editor of the Electrical Review

Price $1.00, postage prepaid

Light for All on Electricity

Electricity plays so great a part in modern life that every one meets it in one form or another every day, and many people are annoyed because they do not know something about it. The information they desire is supplied, so far as it can be without mathematics or technical language, in a very well-executed little book, "The How and Why of Electricity. A Book of Information for the Non-Technical Reader," written by the late Charles Tripler Child, who was technical editor of the *Electrical Review*, and published by the Electrical Review Publishing Company. It explains how electricity is generated and the various practical applications, from the telegraph to the radiograph and wireless telegraphy, in simple and clear language that every one can understand. The descriptions are helped out with cuts and diagrams that really explain. We know nothing that gives so much real help on a difficult and complex matter in so short a space.—*New York Sun, December 27, 1902.*

Admirably Adapted for the Non-Technical Reader

Charles Tripler Child's "How and Why of Electricity" is admirably adapted to instruct the non-technical reader who is interested in that subject. Previous to his recent death, the author was a valuable member of the editorial staff of the New York "Electrical Review," under whose auspices this excellent book is published. Mr. Child enjoyed a high reputation for the clearness and intelligibility of his writing, and the volume in question exhibits these qualities. No attempt is made to tell what electricity is. The wisest men confess their ignorance on that point. But an insight is afforded into the construction and operation of such common devices as the telegraph and telephone, the motor and dynamo, the magnet and induction coil, arc and incandescent lights, Hertz waves, X-rays, and the trolley.—*New York Tribune, December 26, 1902.*

CONTENTS

CHAPTER	
	Preface.
I	The Electric Current.
II	The Electric Battery.
III	The Effects of Electric Flow in the Circuit—Heat and Chemical Action.
IV	The Effects of Electric Flow Outside the Circuit—Magnetism and Induction—The Electrical Units.
V	Electromagnets—The Telegraph.
VI	Electric Signaling Apparatus.
VII	The Relations Between Magnets and Electric Currents.
VIII	Induction and Reactive Coils.
IX	The Telephone.
X	Telephone Accessories.
XI	The Mechanical Generation of Electricity.
XII	The Dynamo Machine.
XIII	Various Types of Dynamo Machines.
XIV	Alternators—Polyphase Currents.
XV	The Electric Motor.
XVI	The Electric Railway.
XVII	Polyphase Currents and Motors.
XVIII	Electrical Power Transmission.
XIX	The Incandescent Light.
XX	The Arc Light.
XXI	Electrochemistry—Storage Batteries.
XXII	Wireless Telegraphy.
XXIII	Radiation—X-Rays.

Address **ELECTRICAL REVIEW**

Book Department **13 Park Row, NEW YORK**

Why is it that motors and dynamos are not warranted as steam engines are guaranteed?

Simply because their builders have not had time, in the rushing growth of their business, to perfect fine details, as the engine builders have learned.

No dynamo or motor should have chemically imperfect insulation in its vitals any more than an engine should have a chemically imperfect piston rod.

The same methods of chemical science which substituted good steel for poor have produced ARMALAC to take the place of "insulating" varnish.

Address all inquiries "INSULATION DEPT."

Massachusetts Chemical Co.

170 Summer Street, BOSTON, MASS., U. S. A.

Insulation Plant and Rubber Works, Walpole, Mass.

Authorized Agencies carrying Stock of Genuine Goods:

W. R. GARTON CO.
118 Jackson Boulevard
CHICAGO, ILL.

ELECTRIC, RAILWAY & MFRS. SUPPLY CO.
68-72 First St.
SAN FRANCISCO, CAL.

CONSUMERS' RUBBER CO.
199 Bank Street
CLEVELAND, O.

CARTER & GILLESPIE ELECTRIC CO.
40 North Broad St.
ATLANTA, GA.

J. H. ASHBY
Hennen Building
NEW ORLEANS, LA.

AMERICAN GENERAL TRADING CO.
136 Liberty St. and 139 Cedar St.
NEW YORK

JAS. CLARK, Jr. & CO.
315 West Main Street
LOUISVILLE, KY.

P. J. DOWN
Harpenden, Herts
ENGLAND

PHILIPP MUHSAM
Alexandrinenstrasse 11
BERLIN, GERMANY

PERSICANER & CO.
VIENNA and BUDAPEST

VICTOR DOURIN
28 Rue de la Montagne
BRUSSELS

NATIONAL ELECTRICAL CODE STANDARD

IXL
Weather-Proof
Slow Burning Weather-Proof
Slow Burning Wire

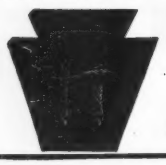
PRICES AND SAMPLES ON APPLICATION

COLLYER INSULATED WIRE AND CABLE CO. PAWTUCKET R. I.

REMOVAL NOTICE

THE OFFICE OF
The Safety Insulated Wire & Cable Co.
IS NOW AT
114 & 116 LIBERTY ST.
WORKS BAYONNE, N. J. NEW YORK

HAZARD MANUFACTURING CO., WILKESBARRE PA.



HIGH-GRADE RUBBER-COVERED WEATHERPROOF **WIRES and CABLES.**

Magnet, Office, Annunciator Wire.

NEW YORK OFFICE, 50 DEY STREET. CHICAGO OFFICE, 1201 MARQUETTE BUILDING.

HABIRSHAW WIRES AND CABLES

The India Rubber and Gutta-Percha Insulating Co.

SALES OFFICE, 15 CORTLANDT ST., NEW YORK
OFFICE AND FACTORY, GLENWOOD WORKS, YONKERS, N. Y.

The "CLARK" Wire

FOR SWITCHBOARD, RAILWAY AND MOTOR USE.

All sizes of stranded and flexible wire and cables with Clark's insulation.

Inspector Boston Fire Underwriters' Union says:—"A thoroughly reliable and durable wire in every respect."

The Clark wire has been before the public, and in use, for the past 10 years and has met with universal favor. We guarantee our insulation wherever used, Aerial, Underground, or Submarine, and our net prices are as low, if not lower than any other first-class insulated wire. We shall be pleased to mail Catalogues, with terms and discounts for quantities.

Eastern Electric Cable Company,
61-63 HAMPSHIRE STREET, BOSTON, MASS.
Henry A. Clark, Treas. and Gen. Manager. Herbert H. Eustis, Prest. and Electrician.

New York Agents
General Electric Co.'s
Edison Lamps

Stanley & Patterson
(Incorporated)

Manufacturers of
General Electrical
Equipment Supplies

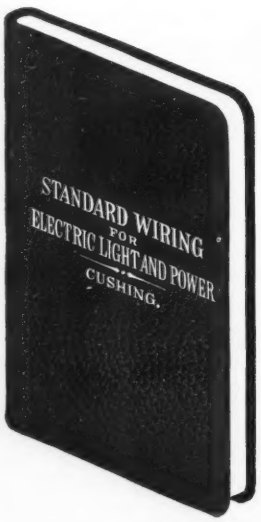
93 Liberty Street, • • New York
Uptown—329 Fourth Avenue—Store

STEEL OUTLET AND JUNCTION BOXES

Switchboards, Panel Boards, Switches, Etc.
..MADE BY..
THE BOSSERT ELECTRIC CONSTRUCTION CO.
UTICA, N. Y.

CARBONS and lamp filaments baked with Dixon's No. 1365 Graphite do not lose their carbon. Furnished in any degree of fineness. Ask for booklet 48.
JOSEPH DIXON CRUCIBLE CO., JERSEY CITY, N. J.

THE 1902 EDITION



Standard Wiring

For Electric Light and Power

By H. C. CUSHING, Jr., A. I. E. E., Electrical Engineer and Inspector.

ADOPTED By the Fire Underwriters of the United States
By Cornell University, Stanford University and other Technical Colleges and Schools
By over 47,000 Electrical Engineers, Central Station Managers and Wiremen

BECAUSE It is the only book on Wiring and Construction kept strictly up to date
It contains all the necessary Tables, Rules, Formulas and Illustrations
It settles disputes, and if referred to before wiring will prevent disputes

FLEXIBLE LEATHER COVER (Pocket Size) $1. Sent post paid upon receipt of price, by

ELECTRICAL REVIEW PUB. CO., 13-21 Park Row, NEW YORK

A Star of the First Magnitude

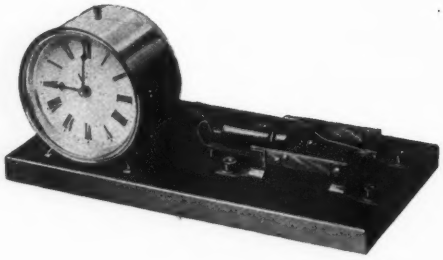
The Standard for Rubber Insulation

The Okonite Company, Ltd.

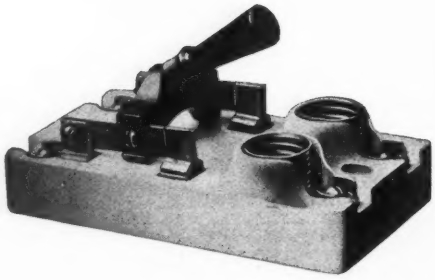
Manufacturers of Insulated Wires and Cables

253 Broadway **NEW YORK**

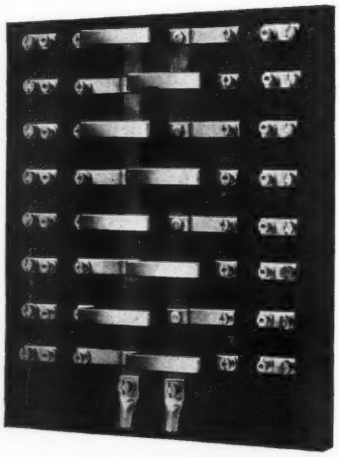
Banner Specialties



All made in Strict Compliance with Underwriters' Rules



BEST MATERIAL!
BEST WORKMANSHIP!
Every Article Guaranteed!



Write for Prices and Complete Information Regarding These and Our Other Specialties

The Banner Electric Co.

Youngstown, Ohio, U. S. A.

The Every Day Wear and Tear

soon puts the ordinary Shop or Tote Box out of business.

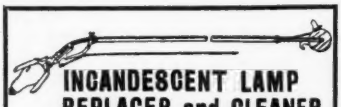
"Lyon" Steel Boxes

ARE NOT ORDINARY—THEY LAST

We make all kinds of Steel Boxes, Steel Barrels, Lathe Pans, Oily Waste Cans, etc.

Send for Our Illustrated Catalogue

LYON METALLIC MFG. COMPANY
137-139 Fulton Street, Chicago



INCANDESCENT LAMP REPLACER and CLEANER
HANDLES THEM AT ANY HEIGHT OR ANGLE
Incandescent Electric Light Manipulator Co.
116 Bedford St., Boston, Mass.

QUICK AND GOOD WORK is the kind that

BURNLEY SOLDERING PASTE (Patented)

will help you to do. Put up in 2 oz., 4 oz., ½ lb., 1 lb., 5 lb., 10 lb. and 50 lb. packages.

Stick and Paste

The Burnley Battery and M'f'g Co.
Painesville, Ohio

DRY BATTERIES

"Boch Glaze Filled"

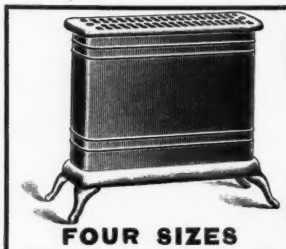
Patented March 8 and 22, 1898.

The name of the best **High Voltage Porcelain Insulator** made.

Ask for particulars and tests. Manufactured exclusively by

THE R. THOMAS & SONS CO.,
EAST LIVERPOOL, OHIO.

Sales Office:
39 and 41 Cortlandt St., NEW YORK.



ELECTRIC STOVES
From 1,000 to 6,000 Watts Capacity
SEND FOR CATALOGUE

FOUR SIZES

American Electrical Heater Co.
17-19 SPENCER ST., DETROIT, MICH.

The

American Bell Telephone Company,

125 Milk Street, Boston, Mass.

INFRINGEMENT

Notice is hereby given that this company owns U. S. patents issued May 10, 1898, October 17, 1899, October 24, 1899 and January 1st, 1901.

These patents together with others now pending and shortly to be issued cover all practical forms of baby filament turn-down lamps constructed to fit the three standard types of sockets in general use. Dealers and users of electrical apparatus are therefore notified that they become liable to us in the making or selling or using of any form of turn-down lamp employing a baby filament, and infringing the above patents.

THE PHELPS COMPANY, Detroit, U. S. A.

The dealer in electric lamps will get more net money and less net "trouble" from imperfect lamps thrown back on his hands if he sells the original genuine

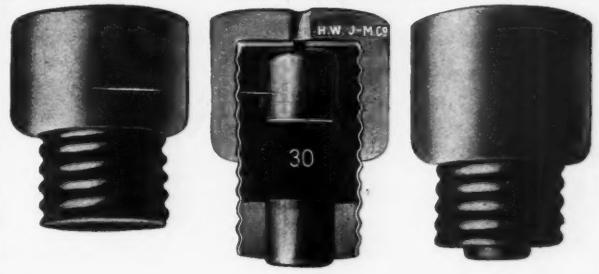
HYLO

SACHS TRADE NOARK MARK FUSE

PLUGS

FOR EDISON PLUG CUT-OUTS AN APPROVED 220-VOLT

FUSE DEVICE See "National Electric Code"



Owing to the indestructability of the Plug Shell, it is cheaper to use "NOARK" Plugs than any other kind. Replacing a plug cartridge fuse is cheaper than replacing a whole plug.

A SINGLE SHELL CAN BE INTERCHANGEABLY USED WITH "NOARK" FUSES RANGING FROM 1 TO 30 AMPERES.

FITS ANY STANDARD EDISON CUT-OUT BLOCK. ALL INSULATING PARTS ARE PORCELAIN.

Write for Latest Edition "Noark" Fuse Bulletin.

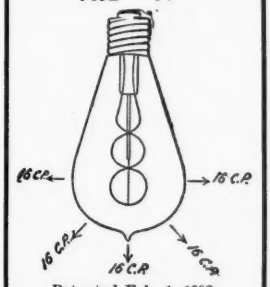
NEW YORK MILWAUKEE CHICAGO ST. LOUIS BOSTON

H.W. JOHNS-MANVILLE CO 100 WILLIAM ST. NEW YORK

PHILADELPHIA CLEVELAND PITTSBURG NEW ORLEANS LONDON

DON'T WASTE YOUR MONEY YOU MAY WANT IT

THE "IT"



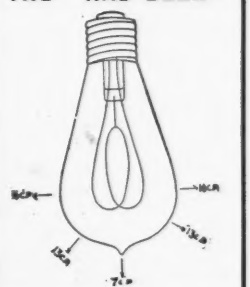
Patented Feb. 1, 1902.

THE STERLING SPECIAL		
Side	16	Candle-Power
Angle	16	" "
Tip	16	" "
Average	16	" "

Write "Sterling Special"

on your orders for incandescent lamps. Study the cuts and see WHY you use the SAME current and you get 128 per cent MORE LIGHT.

THE "HAS BEEN"



THE OTHER KIND		
Side	16	Candle-Power
Angle	13	" "
Tip	7	" "
Average	12	" "

STERLING SPECIAL
AVERAGES 16 CANDLE-POWER

THE OTHER KIND
AVERAGES 12 CANDLE-POWER

Send for Prices and Samples

STERLING ELECTRICAL MFG. CO., Warren, Ohio

ELECTRICAL MECHANICAL CONSULTING

DIRECTORY OF ENGINEERS

CONTRACTORS SPECIAL INTERESTS

ARNOLD ELECTRIC POWER STATION COMPANY,
ENGINEERS, CONTRACTORS.
For Complete Electric Plants. Results Guaranteed.
SUITE, 1539 MARQUETTE BLDG., CHICAGO.
New York Office, 711 Transit Building.

LAMAR LYNDON,
CONSULTING ELECTRICAL ENGINEER.
Long Distance Power Transmission and Alternating Current Problems a Specialty.
PARK ROW BUILDING, NEW YORK.

POWER INSTALLATION CO.
ENGINEERS
GEO. F. WESCOTT
ECONOMICAL DEVELOPMENT AND TRANSMISSION
202 MAIN ST., BUFFALO
BOSTON OFFICE--719-720 TREMONT TEMPLE

SHEAFF & JAASTAD,
MECHANICAL and ELECTRICAL ENGINEERS.
Plans and specifications for and superintendence of Electric Power and Lighting Plants a specialty.
85 WATER STREET, BOSTON, MASS.

BAKER, JOSEPH B.
CONSULTING ELECTRICAL ENGINEER
161 SUMMER STREET, BOSTON, MASS.
Telephone, 1094 Oxford

THOS. J. McTIGHE, Consulting Engineer.
Mechanical, Reports,
Electrical, Estimates,
Mining, Supervision,
Inventions.
1138 Park Row Building,
13-21 PARK ROW, NEW YORK.

FRANK B. RAE,
Electrical and Mechanical Engineer,
ALDRICH COURT, 45 BROADWAY,
NEW YORK.
Designs, Specifications, Estimates, Valuations, Tests and Expert Work. Electric Railways, Lighting and Power Transmissions Steam and Hydraulic Work.

J. H. VAIL,
Mechanical and Electrical Engineer,
Rooms 715-18 Hale Building,
1328 CHESTNUT ST. PHILADELPHIA, PA.
Plans, specifications, contracts, reports. Twenty years' practical experience. Electric lighting. Railways. Power transmission.

W. S. BARSTOW,
CONSULTING ELECTRICAL and MECHANICAL ENGINEER,
11 BROADWAY, NEW YORK.
Plans and Supervision of Installation of Complete Lighting, Power and Railway Plants. Special Reports on Electrical Properties.
Telephone, 4671 Broad.

New England Engineering Co.
100 BROADWAY, NEW YORK. WATERBURY, CONN.
Electric Railways, Electric Light and Power Plants, Gas and Waterworks, or any other engineering installations built or remodeled.

ARVID REUTERDAHL,
CONSULTING STORAGE BATTERY ENGINEER.
67-69-71 FOUNTAIN STREET,
PROVIDENCE, R. I.

J. G. WHITE & COMPANY,
INCORPORATED,
ENGINEERS, CONTRACTORS,
29 Broadway, New York, N. Y.
LONDON CORRESPONDENTS:
J. G. WHITE & CO., Ltd.,
22A COLLEGE HILL, CANNON STREET.

GEO. T. HANCHETT,
CONSULTING AND ELECTRICAL ENGINEER,
114-116 NASSAU ST., NEW YORK.

POWERS'
CENTRAL STATION STREET RAILWAY DIRECTORIES.
Complete, up-to-date manuals for Financial, Official, Electrical and Mechanical Reference.
THE E. L. POWERS CO., PUBLISHERS,
150 NASSAU ST., NEW YORK.

F. O. RUNYON,
CONSULTING ELECTRICAL ENGINEER,
122 MARKET STREET, NEWARK, N. J.

C. H. WILMERDING,
CONSULTING ENGINEER,
184 LA SALLE STREET, CHICAGO.
Design and Construction of Electric Lighting and Power Plants. Electrical Equipment of Mills, Factories and Shops. Underground Distributing Systems, Estimates, Reports.

SCIENCE ABSTRACTS, PHYSICS AND ELECTRICAL ENGINEERING

PUBLISHED MONTHLY

Issued under the direction of the INSTITUTION OF ELECTRICAL ENGINEERS and the PHYSICAL SOCIETY OF LONDON

A most invaluable publication. Its name sufficiently implies its scope and purport. Its abstractors, some sixty odd, are necessarily leading experts in the branches they undertake.

SCIENCE ABSTRACTS has a wide and influential circulation. It is officially taken by all the members of the above-named societies, and has a strong outside circulation by subscription and otherwise.

It follows that it is an excellent advertising medium Advertising space is limited. All particulars from the Publishers and Advertising Contractors.

THE FEILDEN PUBLISHING CO., Ltd., Gwydir Chambers, 104 High Holborn, London, W. C.

Power Plants of the Pacific Coast

A special edition of the paper read by Dr. F. A. C. Perrine before the New York Electrical Society descriptive of the great transmission systems of California. Includes illustrations of the great Carquinez Span, also fifty other illustrations.
Bound in boards, 8 1-4 inches by 10 3-4 inches. Price 50 cents, postpaid.

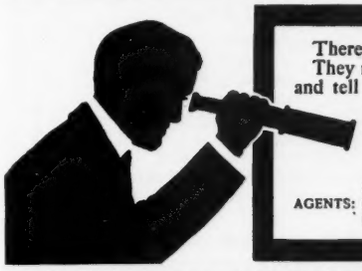
Address **Electrical Review Publishing Company**
13 PARK ROW **NEW YORK**
BOX 339

I-T-E CIRCUIT BREAKERS

AFFORD AUTOMATIC AND INSTANTANEOUS PROTECTION TO MOTORS AND GENERATORS. MADE IN ALL SIZES AND FOR EVERY VARIETY OF INSTALLATION. LITERATURE AND CATALOGUES UPON REQUEST : : : :

THE CUTTER CO.
19th and Hamilton Sts.
PHILADELPHIA

PORTER & BERG, 300 Dearborn Street, Chicago
C. M. CROFOOT, 234 W. 4th Street, Cincinnati
T. H. BIBBER & CO., 37 Arch Street, Boston
G. A. ANNABLE, 120 Liberty Street, New York
JOHN R. COLE, 33 Second Street, San Francisco
W. C. JESSUP, 203 Lewis Building, Pittsburg



There are a number of good features about C & H goods that are not to be found in others. They make good talking points for us---and good working points for you. Our catalogues show and tell everything about them. Write for them.

C. & H. RHEOSTATS AND ELECTRIC CONTROLLING DEVICES
THE CUTLER-HAMMER MFG. CO.

AGENTS: Sturtevant Engineering Co. Ltd., London, Eng.
Edge & Edge, Sidney, Australia.
Kilbourne & Clark Co., Seattle, Wash.

MAIN OFFICES AND FACTORY—MILWAUKEE
BRANCH OFFICES—NEW YORK, CHICAGO & PITTSBURG.

GEORGE T. EYANSON & CO.
15 N. Seventh Street, Philadelphia, Pa.
MANUFACTURER OF
High Grade Switches Switchboards and Panel Boards
FOR ALL USES

High Power Transmission
made possible by insulators of the Locke "Victor" type. Every insulator is tested far beyond the capacity for which it is sold before it is shipped.

LOCKE VICTOR
type adopted by the Bay Counties' Power Co. and the Standard Electric Co., of California, for the largest and highest voltage line in the world.

FIVE MILLION LOCKE INSULATORS IN DAILY USE

Send for Catalogue No. 6 and ask for Surface Leakage Tests.

The Locke Insulator Mfg. Co.
Victor, N. Y., U. S. A.

JOHN MARTIN & Co., 33 New Montgomery St., San Francisco, Cal.; Pioneer Bldg. Seattle, Wash.—Pacific Coast.
WM. E. PECK & Co., 116 Broad St., New York—Australia, Mexico, South America.
GUIDO TOLUSSO Via Torino 61, Milan, Italy.

Continuous Rail Joint Co. of America.

General Offices,
Century Building, Newark, N. J.

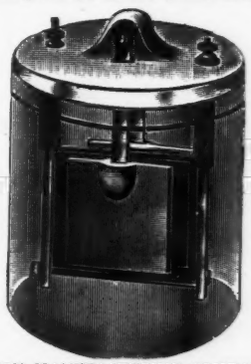
OVER FIFTEEN THOUSAND MILES IN USE.

WHEN ADDRESSING ADVERTISERS PLEASE MENTION THIS PAPER.

WE ARE PREPARED TO FURNISH
KNIFE SWITCHES
Arranged for all standard makes of Enclosed Fuses
We have all styles and sizes of Clips for Enclosed Fuses IN STOCK. Send us your order for
SWITCHES, PANEL and SWITCHBOARDS
W. S. HILL ELECTRIC COMPANY
NEW BEDFORD, MASS.

EDISON PRIMARY BATTERIES
Formerly known as the Edison-Lalande.

FOR GAS ENGINES,
SLOT MACHINES,
AUTOMOBILES,
RAILROAD SIGNALS,
CROSSING BELLS,
SMALL MOTORS,
ETC...



CONSTANT CURRENT,
NO LOCAL ACTION,
WILL NOT FREEZE.
LIQUID TIGHT
CELLS FOR
PORTABLE
WORK.
Full Description in
Booklet No. 17.

EDISON MANUFACTURING COMPANY.
Factory, Orange, New Jersey, U. S. A.
New York Office, 83 Chambers Street.
Chicago Office, 144 Wabash Avenue.

H. N. FENNER President J. F. BLAUVELT, Agent RUSSELL W. KNIGHT, Treasurer
NEW ENGLAND BUTT COMPANY
MANUFACTURERS OF
MACHINERY for INSULATING ELECTRICAL WIRES
Braiding Taping, Winding, Twinning, Cabling, Stranding, Polishing and Measuring Machines. Cable Covering Braiders
FINE CASTINGS A SPECIALTY
304 PEARL STREET, - - - PROVIDENCE, R. I., U. S. A.

Eureka
Flexible Conduit

saving 10 to 20 per cent time in installation. It never becomes hard nor brittle and is ALWAYS a conduit pronounced the BEST from Atlantic to Pacific. Write to us or to our agencies.

Look for the Trademark

The Sign of Economy

The Rittenhouse-Miller Company

923 Witherspoon Building
PHILADELPHIA

AGENTS
NEW YORK—J. F. Buchanan & Co., 26 Cortlandt St.
PITTSBURG—James Brown & Son, 207 Wood St.
BOSTON—J. F. Buchanan & Co., 71 Federal St.
CHICAGO—Metropolitan Elec. Supply Co., 183 Lake St.
PHILADELPHIA—J.F. Buchanan & Co., 36 North 4th St.
CLEVELAND—The Geo. Worthington Co.
SEATTLE—Kilbourne & Clark Co., 815-17 Second Ave.
SAN FRANCISCO—Kilbourne & Clark Co , 519 Mission St.
LOS ANGELES—Pacific Electric Works.

WITH ONLY
FIELDING RECEPTACLES
in stock, you will have just the right thing for 60 per cent of your work

JUST SPECIFY

P K

H. T. PAISTE COMPANY

H·C·ROBERTS·
ELECTRIC SUPPLY CO.
831 ARCH ST., PHILADA., PA.
THE BEST GOODS AT FAIR PRICES

THREE-DAY TOUR TO WASHINGTON

Under the Personally-Conducted System of the Pennsylvania Railroad

The next Pennsylvania Railroad Personally-Conducted Tour to Washington leaves Thursday, February 12. Rate, covering railroad transportation for the round trip, hotel accommodations, and transfer of passenger and baggage, station to hotel in Washington, $14.50 from New York, $13.00 from Trenton, and $11.50 from Philadelphia. These rates cover accommodations for two days at the Arlington, Normandie, Riggs Ebbitt, Shoreham, Cochran, Gordon, Barton, or Hamilton Hotels. For accommodations at Regent, Metropolitan, National, or Colonial Hotels, $2.50 less. Special side trip to Mt. Vernon.

All tickets good for ten days, with special hotel rates after expiration of hotel coupons.

For itineraries and full information apply to ticket agents; Tourist Agent, 263 Fifth Avenue, New York; 4 Court Street, Brooklyn; 789 Broad Street, Newark, N.J.; or address Geo. W. Boyd, Assistant General Passenger Agent, Broad Street Station, Philadelphia.

Name Plates
for machinery

We make name plates for some of the largest makers of machinery in the U. S. and we would be pleased to send you sample and quote price.

No Plate Too Large or Too Small

Murdock Parlor Grate Co.
159 Boylston St., Boston, Mass.
U. S. A.

ELECTRIC HEATING APPARATUS
OF EVERY DESCRIPTION
"Unit" Enamel Rheostats
The Simplex Electric Heating Co.
CAMBRIDGEPORT MASS.

ELECTRIC DIALS
The most convenient and reliable method of furnishing uniform time in factories, schools, mills and other large buildings. Readily installed and easily maintained. Also Frying-Pan, Program, Sixty-Day and Calendar Clocks.
Send for Catalogue No. 208.
The Prentiss Clock Improvement Co.
Dept. 20, 49 Dey St., NEW YORK CITY

Tuerk Alternating Current **CEILING FANS**
HUNTER FAN & MOTOR CO.
General and Export Agents **FULTON, N. Y.** Western Agents
E. B. LATHAM & CO. 39 Vesey St., New York
WESTERN ELECTRIC CO. Chicago and St. Louis

LAVITE

Insulating washers, bushing, etc., with or without shoulder. Accurately treaded. Samples quickly and cheap. You should know about it.
Our trade-mark LAVITE on every box.

D. M. Steward Mfg. Co.
Chattanooga, Tenn.
8 Jay Street, New York.
57 Washington Street, Chicago. (1)

THE ELECTRICAL REVIEW reaches and is read by the men you wish to do business with.

COMPLETE SUBWAY SYSTEMS
BUILT FOR ALL PURPOSES
G. M. GEST, Expert Subway Contractor
CINCINNATI, OHIO 277 BROADWAY, N. Y.

WANTED

Position with a New York City, or vicinity, Manufacturing Concern, in Executive Branch, by young man experienced in office administration. Have been manager large boiler construction works. Loyal and faithful worker. Sober and industrious. Good, systematized. Best reference. :: :: :: :: ::

X. P. M.
Care Electrical Review, 13 Park Row, New York

SHELBY LAMPS SHELBY, OHIO.

CARBONS
CONSUMERS CARBON CO.
LANCASTER, OHIO, U. S. A.
Carbons of all kinds and for all purposes.

A College Graduate Benefited By the I. C. S.

After completing the mechanical engineering course in the Iowa State College, I secured a position with an electric manufacturing concern in Cincinnati. I worked two years, when I saw that, to become proficient, I would have to get more education; so I enrolled in your Electrical Engineering Course. I can truthfully say that I have received more practical knowledge from your Course than I did from my college course. I am now electrical engineer and superintendent of the Dynamo and Motor Department of the Kentucky Electrical Company; and my salary is double what it was when I enrolled. I would advise any young man who desires to become an electrician to enroll with the Schools.

A. W. STUNTZ, *Owensboro, Ky.*

This is but one of many hundred indorsements proving that our students succeed. Our new free booklet, "1001 Stories of Success," gives the names, addresses, and progress of over a thousand other students whom we have placed on the road to progress and prosperity. No matter how much or how little previous education you have had, we can be of assistance to you. Start TODAY to rise!

Fill Out and Send In the Coupon NOW!

International Correspondence Schools,
Box 1003, SCRANTON, PA.

Please send me, free, a copy of "1001 Stories of Success"; and explain how I can qualify for position marked X below:

	Electrical Engineer		Gas Engineer
	Telephone Engineer		Refrigeration Engineer
	Erector of Electric Machinery		Marine Engineer
	Manager Electric Railway		Steam Engineer
	Manager Electric-Light Plant		Civil Engineer
	Supt. Elec.-Light & Power Plant		Architect
	Fire Underwriters' Inspector		Chemist
	Interior Wireman		Cotton-Mill Supt.
	Foreman Dynamo Room		Woolen-Mill Supt.
	Foreman Electrical Repairs		Textile Designer
	Dynamo Tender		Navigator
	Electrician		Bookkeeper
	Electrical Lineman		Stenographer
	Motorman		To Speak French
	Mechanical Engineer		To Speak German
	Mechanical Draftsman		To Speak Spanish

Name _____

Street and No. _____

City _____ *State* _____

FLOTATION IN AIR

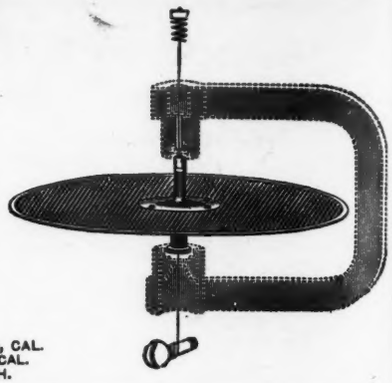
OF THE MOVING PARTS OF
STANLEY RECORDING WATTMETERS
FOR ALTERNATING CURRENT
IS ACCOMPLISHED BY

MAGNETIC SUSPENSION

NO WEAR
NO FRICTION

NO LOST REVENUE
ALL CURRENT USED RECORDED

SEND FOR DESCRIPTION AND BOOK FULL OF GOOD INFORMATION
"ABOUT METERS"



STANLEY INSTRUMENT CO.
GREAT BARRINGTON, MASS., U. S. A.

PACIFIC COAST AGENTS
JOHN MARTIN & CO. { SAN FRANCISCO, CAL. / LOS ANGELES, CAL. / SEATTLE, WASH.

American Conduit Co.

Manufacturers of

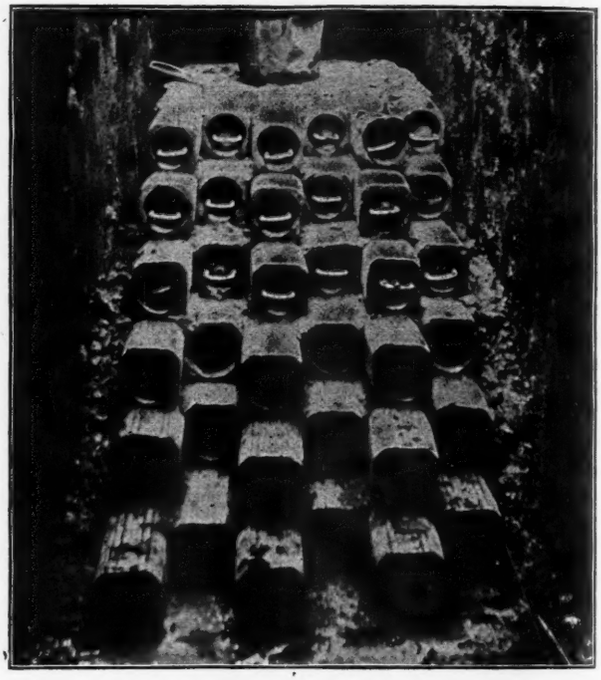
Bituminized Fiber Conduit (Patented)

For UNDERGROUND ELECTRICAL WORK

Our Conduit is { ELECTROLYSIS-PROOF / NON-ABRASIVE / MOISTURE-PROOF / NON-CORROSIVE / CHEAPLY and RAPIDLY LAID } Insulation Test 66,000 Volts

We give you a perfect joint, which is self-aligning and makes each duct a continuous tube from manhole to manhole.
It will pay all those interested in subway construction to write us for particulars and prices before closing contracts for Conduit. State sizes and quantity desired.

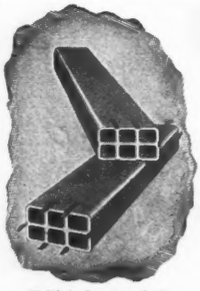
Offices: 720 Arcade Building, PHILADELPHIA, PA.
822 Manhattan Building, CHICAGO, ILL.
336 Macy St., LOS ANGELES, CAL.
Factories: Chester, Pa., Chicago, Ill., Los Angeles, Cal.



CAMP CONDUIT
Laid for Georgia Electric Co. (Atlanta)
By G. M. Gest, Contractor

H. B. CAMP CO.

Largest Manufacturers of
VITRIFIED CLAY CONDUIT
170 Broadway, New York 85 Hartford Building, Chicago
☞ Address Department F. when writing



Multiple Duct made in 2-3-4-6 and 9 Ducts

Underground Conduit

INSULATORS AND SPECIAL CLAY PRODUCTS

The SINGLE DUCT is self-centering
The MULTIPLE DUCT embodies new patent features for rapid construction

We have one of the largest and best equipped factories with improved machinery. A corps of skilled workmen who know how to make good conduit, and UNEQUALED SHIPPING FACILITIES

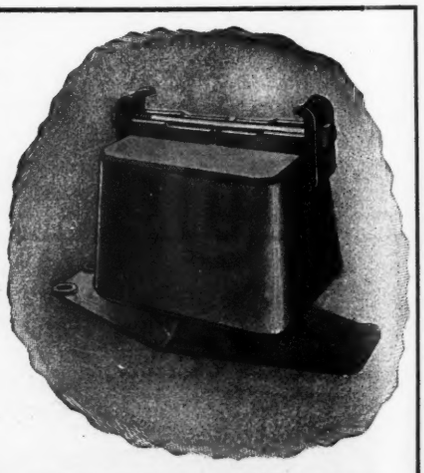
CATALOGUE ON REQUEST

STANDARD VITRIFIED CONDUIT CO.

39-41 Cortlandt Street, New York

R. W. LYLE
Pres. and Gen'l Manager

B. S. BARNARD
Vice-Pres. and Secretary



Manhattan Elevated Railway, N. Y., Third-Rail Insulator

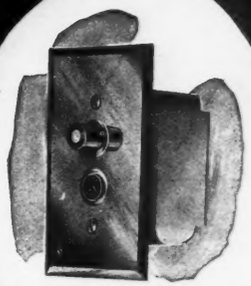
Snap Switches
Indicating Switches
Key Switches
Flush Switches
Gang Plates
Push Button Switches
Art Plates
Door Switches
Baby Knife Switches
Punch Clip Knife Switches
Ed., T. H. & West. Key Sockets
Receptacles
Weatherproof Sockets
Attachment Plugs
Midget Plugs & Receptacles
Rosette Plugs & Receptacles
Flush Plugs & Receptacles
K. W. Cut-Outs
Competition Cut-Outs
Branch & Main Cut-Outs
Dow Adjusters
Gongs
Watchman's Registers

SUCCESS

"'Tis not in mortals to command success.
We'll do more Sempronius; we'll deserve it."

The new model Push Switch deserves success. The thought and study spent in its design, the rigid scrutiny of the materials used and the rare quality of mechanical skill displayed in its manufacture are all elements of success.

Among other points of superiority may be mentioned one-piece porcelain, convenience of wiring, mica insulation, one size and style of plate fitting all conduit boxes.



No. 531 1903
Push Button Switch

IF YOU DO NOT RECEIVE OUR REMINDERS, SEND YOUR BUSINESS CARD AND GET THE "CHOICE STUFF" WEEKLY. PLEASE MENTION ELECTRICAL REVIEW.

MARSHALL-SANDERS CO.

BOSTON, MASSACHUSETTS

HART & CO., Monadnock Bldg., Chicago, Ill.

Before Contracting for
INCANDESCENT LAMPS
Get the STERLING SPECIAL Literature.
STERLING ELECTRICAL MFG. CO.
Warren, Ohio.

In making advertising copy do not condense ideas—rather condense words

Smith Tray Plate Storage Battery

Most Compact. Most Efficient. Lightest. No Internal Resistance.

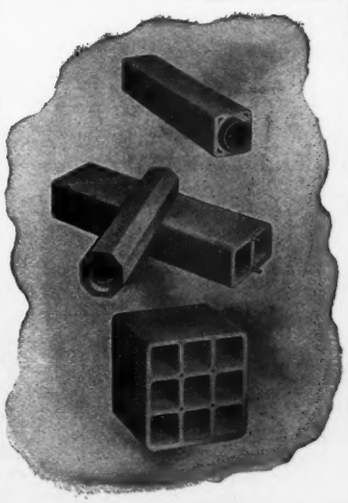
Smith Storage Battery Company
196 State St., Binghamton, N. Y.

THE SIMPLEST, MOST PRACTICAL AND ECONOMICAL TURN-DOWN ELECTRIC LAMP EVER INVENTED

The ECONOMICAL

Style 1 -Pull string for bright or dim. Style 2—For variation in light turn bulb one way or the other. Write for booklet and prices. All voltages and bases.

ECONOMICAL ELECTRIC LAMP CO. 123 LIBERTY STREET NEW YORK



American Vitrified Conduit Co.

GENERAL OFFICE — Broadway-Maiden Lane Building, NEW YORK

Manufacturers of VITRIFIED GLAZED CONDUIT

MANHATTAN THIRD-RAIL INSULATOR

40,000 of this type Insulator furnished by us to Manhattan Railway Co. of New York

Have a Care

in buying FAN MOTORS—
Which means your carefulness will lead you to purchase the PEERLESS.

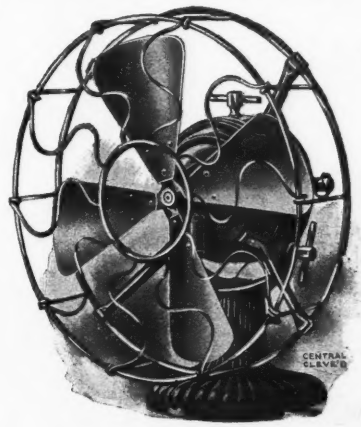
Lack all Care

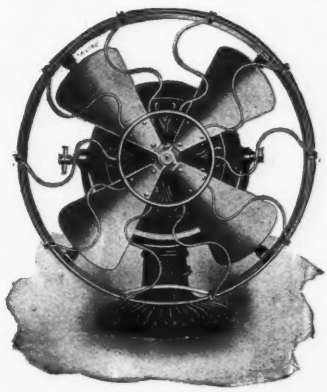
then, when the Fans are subjected to the severest usage—they'll meet every test.

DO NOT OVERLOOK THE MODERATE PRICE CEILING FAN,
WHICH WILL WEAR EQUAL TO THE BEST

PEERLESS FANS PROMISE AND PERFORM WITH ALL THAT EXACTNESS THAT THEY BALANCE MECHANICALLY AND ELECTRICALLY. HIGH FINISH, TASTEFUL DESIGN, PERFECT FIT OF PARTS SUPERIOR MATERIALS, UNEQUALED CONSTRUCTION AND "WESTERN RESERVE" WORKMANSHIP ACCOUNT FOR THE ENVIABLE REPUTATION OF PEERLESS FANS.

IN ADDITION TO THE WELL KNOWN TYPES OF DIRECT CURRENT DESK, BRACKET, AND CEILING FANS, WE NOW OFFER A LESS COSTLY CEILING





FAN FINISHED IN BLACK JAPAN, A NEAT COLUMN FAN, AND A WINNER IN THE FORM OF AN ALTERNATING CURRENT DESK AND BRACKET FAN.

THE PEERLESS LINE IS COMPLETE, COVERING A WIDE RANGE OF STYLES, AND THE STANDING WITH THE TRADE IS BEST EVIDENCED BY THE PROMINENCE OF THE JOBBING HOUSES THAT HAVE PEERLESS AGENCIES.

The Peerless Electric Co.

Warren, Ohio, U. S. A.

General

Electric Company's

Fan Motors

Season of 1903

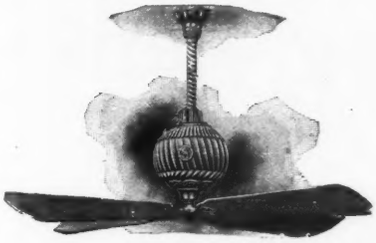
NOW READY FOR SHIPMENT

General Offices, Schenectady, N. Y.

New York Office, 44 Broad Street
Sales Offices in all Large Cities

WRITE FOR INFORMATION

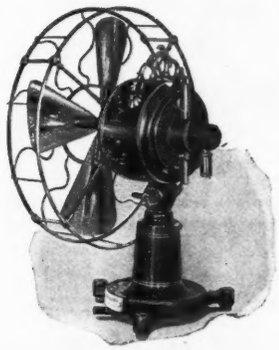
THE STANDARD FANS



ARE MADE IN SEVEN STYLES FOR VARIOUS PURPOSES

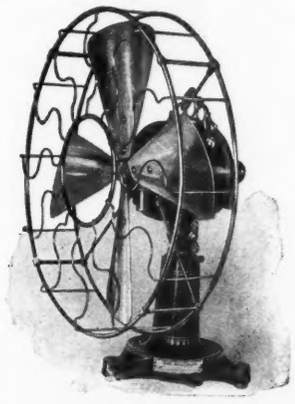
Style "A"—realizes the highest commercial economy. It carries four blades 25 in. long, set at an angle of 25 degrees, and runs at 200 r.p.m., consuming 95 watts of electrical energy. It is made in three finishes. (Circular No. 23.)

Style "B"—is designed for use where saving in the first cost is of more importance than saving of power. It is a high-grade fan of great power—carrying four 25 in. blades at 200 r.p.m., when set at 25 degrees, with a power consumption of 110 watts. It is made in three finishes. (Circular No. 24.)



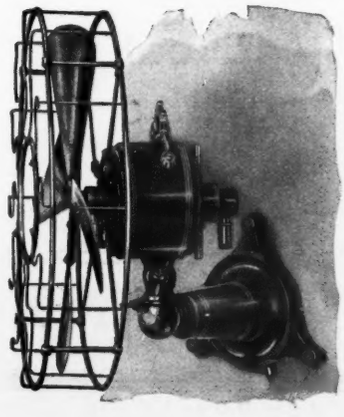
Standard 500-volt Special—is designed especially for use on 500-volt power and railway circuits, and is made throughout to withstand continuously the severe strains of this high pressure service. It runs at 200 r.p.m., with 25 in. blades set at 25 degrees, and consumes 100 watts of power. (Circular No. 25.)

12 in. Desk Fan—moves the largest volume of air with minimum power consumption, using from 35 to 45 watts while running at 1,800 to 2,000 r.p.m.



16 in. Desk Fan—runs at 1,450 to 1,600 r.p.m. and consumes 85 to 95 watts. Both fans are quiet in operation, elegantly finished in black enamel, with gold decoration and lacquered brass blades, guards and small fittings. Both are adjustable so as to direct the current of air towards any point on either a horizontal or vertical plane, and are convertible into bracket fans. They are provided with three speed switches. (Circular No. 22.)

We are making this line of fans in large quantities and can offer them at the lowest prices consistent with first-class workmanship and material.



THE

Robbins & Myers Company

Main Office and Works, SPRINGFIELD, OHIO

New York Office, 170 Broadway. Stock Carried in N. Y. City

Tuerk Alternating Current Ceiling Fans

1903 MODEL

ELECTROLIER MODEL
Made with 2, 3 and 4 Lights

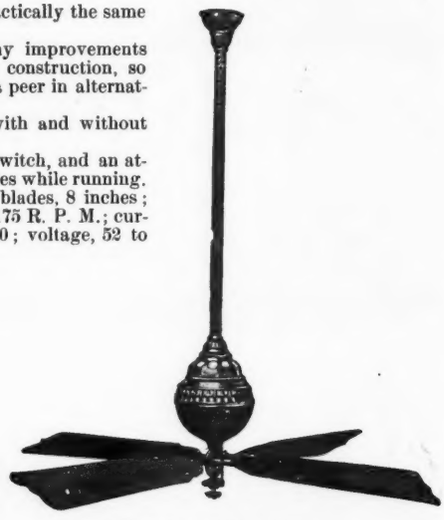
THE design of the Tuerk Fan remains practically the same as originally placed upon the market.

Advantage has been taken of any improvements possible in their electrical and mechanical construction, so that to-day the Tuerk Fan stands without a peer in alternating Current Ceiling Fans.

They are made with 2 and 4 Blades, with and without Electrolier attachments.

Each Fan is provided with a starting switch, and an attachment for adjusting the angle of the blades while running.

Spread of blades, 60 inches; width of blades, 8 inches; speed on both high and low frequencies, 175 R. P. M.; current consumed, 100 watts; cycles, 40 to 140; voltage, 52 to 230. Write for Catalogue and Prices.



FOUR BLADE MODEL

Hunter Fan & Motor Company

FULTON, N. Y., U. S. A.

GENERAL AND EXPORT AGENTS:
E. B. LATHAM & CO., 39 Vesey Street, New York, U. S. A.

WESTERN AGENTS:
WESTERN ELECTRIC COMPANY, Chicago, Ill.
WESTERN ELECTRIC COMPANY, 810 Spruce Street, St. Louis, Mo.

BATES ELECTRIC FANS

"IMPERIAL" 3-Speed Ceiling Fan and Switch

SOLD THROUGHOUT THE WORLD

DIRECT CURRENT ONLY. CEILING, DESK, WALL, COLUMN, BRACKET AND TRUNNION TYPE

Highest Electrical Efficiency

Before Making Contracts Write for Manufacturer's Catalogue

THE D. L. BATES & BRO. COMPANY

DAYTON, O., U. S. A.

Colonial Excellence

ON this topic much can be said, but we prefer to allow the thousands of pleased users of Colonial Direct Current Fans say it. Stacks of voluntary letters to the company testify to the superiority of Colonial fan motors. However, durability is not the only feature; handsome design and high finish are also accomplished.

The Colonial fans for 1903 are better than ever, and have been improved in several details of manufacture. The line this year includes a black japan finish ceiling fan at moderate price. All desk and bracket fans are swivel and trunnion.

Colonial wares and prices are attractive, the fans have standing with the trade and the user, and the line is strong.

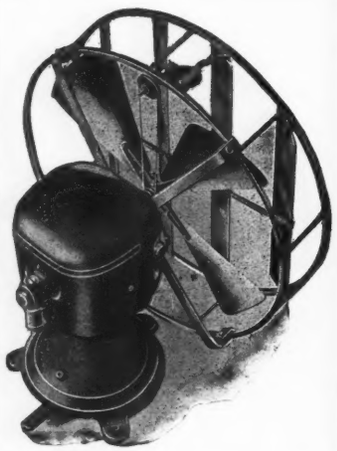
Let us hear from you.

The Colonial Fan and Motor Co.

Ravenna, Ohio, U. S. A.

THE LATEST IDEA IN FANS

IS THE DEFLECTING OF AIR IN ANY DESIRED DIRECTION

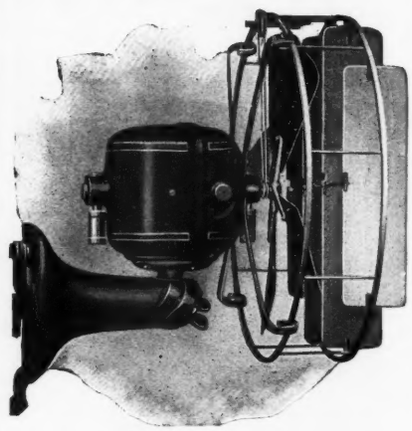


In the "COLEMAN" device this is accomplished by means of vanes operated automatically and attached directly in front of the fan.

POSITIVE IN OPERATION
EASILY INSTALLED
ATTRACTIVE APPEARANCE

May be used on Desk, Bracket, or Trunnion Fans, and may be operated at any angle. Send for Price List and Bulletin describing method of attaching to any make of fan.

OUR NEW FAN CATALOGUE will describe a new type of Ceiling and Electrolier Fan, four blades, two or three speeds.



DIEHL MANUFACTURING CO.

ELIZABETHPORT
NEW JERSEY

Don't close your contract for fan motors until you have written and found out about the

"Eck" Oscillating Fan

Eck Dynamo and Motor Works
BELLEVILLE, N. J., U. S. A.

G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I.

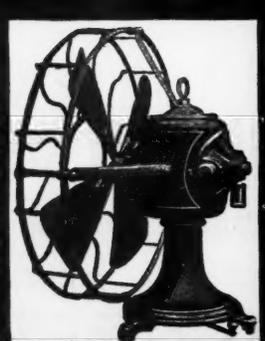
G. I. Co.'s

MINIMUM COST OF CURRENT
NO REPAIRS TROUBLE NOISE
MAXIMUM VOLUME OF AIR

MANUFACTURED BY
General Incandescent Arc Light Co.
NEW YORK, N. Y.

PARAGON

TRUNNION



DESK FANS

BRACKET

FANS

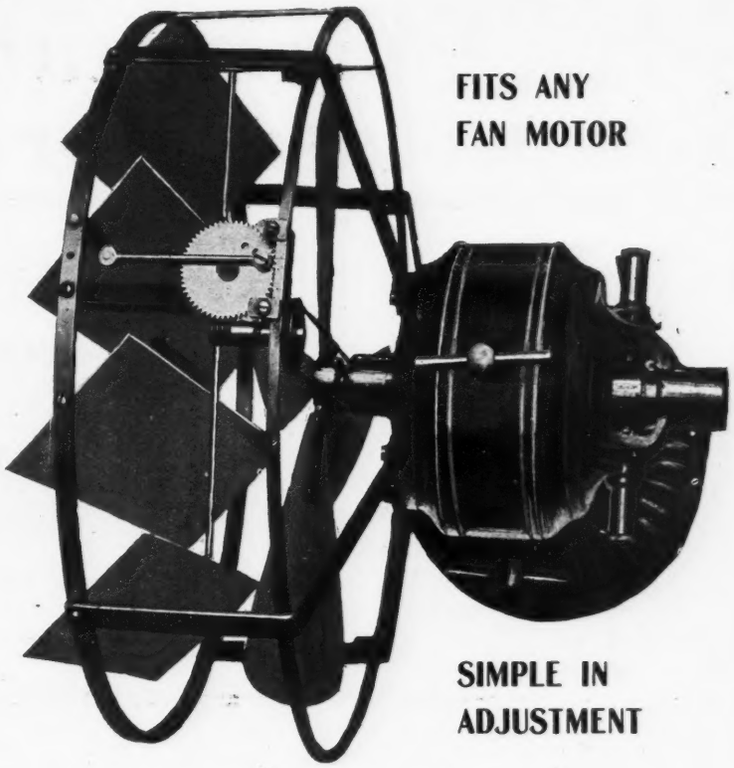
A CHEAP FAN IS THE DEAREST

PARAGON FAN AND MOTOR CO.
572-578 First Ave., New York, N. Y.

OFFICES IN EVERY LARGE CITY OF THE U. S.

Manufacturers of Electric Fans, also Jobbers. Before making up or ordering your fan guards it would pay you to investigate what we offer.

This cut shows the latest, simple, cheap and perfect improvement in the fan line. It is similar to the ordinary guard with deflectors, which are turned from side to side by power taken direct from motor shaft. Is easily attached to any fan and increases its value threefold. Will run in any position and at any speed. The speed of the deflectors is regulated independent of fan—blades and angle adjusted to suit any room. The extra power required to run deflectors is very little, a one-sixteenth-inch rubber band will work them.



FITS ANY FAN MOTOR

SIMPLE IN ADJUSTMENT

For full particulars, address

THE COLEMAN MFG. CO.

No. 71 Cortlandt St., New York

THE CONSOLIDATED "AXLE LIGHT" SYSTEM OF

Electric Lights and Fans

FOR ALL KINDS OF RAILWAY PASSENGER CARS

☞ Adopted as the electric lighting system on Pullman Private Cars and on the finest trains on leading Railway lines

By this system Electricity for the lighting of railway cars is generated by means of a Dynamo driven by the Axle while the car is in motion, and is supplied automatically from storage batteries when the car is stationary.

Each car carries its own electric lighting apparatus, being entirely independent of all other cars or of any charging plant.

Electric lights and fans keep a car appropriately illuminated and ventilated.

The "Axle Light" system is efficient, economical and —above all—Safe; and is rapidly coming into general use.

CONSOLIDATED RAILWAY ELECTRIC LIGHTING AND EQUIPMENT COMPANY

100 BROADWAY NEW YORK

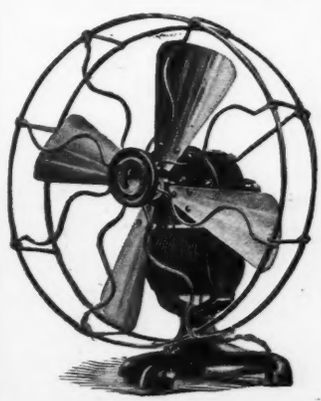
JNO. T. DICKINSON, General Agent, N.Y.
GEO. W. CARHART, General Agent,
83 West Jackson Blvd., Chicago, Ill.

H. M. Abbott
Vice-Pres't and Gen'l Manager

OUR 1903 TYPE PERFECTION BATTERY

FAN MOTOR

IS ALL READY FOR DELIVERY



It is by far the best BATTERY FAN on the market. We do not know of another that compares with it.

It is made up on the lines of regular Fans, and not on the toy lines, as all Battery Fans, heretofore put out, have been.

Motor and Fan complete	$12.50
4-Blade Fan, 10 inches	1.50
Guard	1.50

Discount to Trade

Agents Wanted

J. JONES & SON

MANUFACTURERS OF

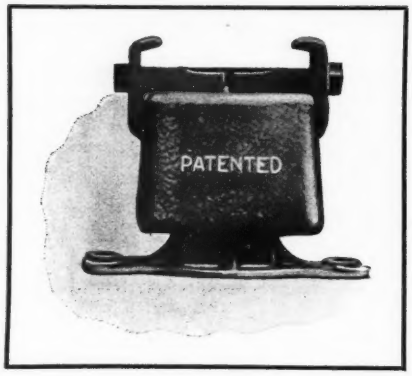
Electrical Specialties and Supplies

64 Cortlandt St., New York, N. Y.

The "Manhattan" Third Rail Type Insulator

WE have acquired the exclusive ownership of letters patent No. 563,483 known as the Haley patent, for the "Manhattan" type of third rail insulator.

This insulator is the one adopted by the Manhattan Elevated Railway, New York, after many experiments. As a consequence it is now using 80,000 of this type



on its system. It has since been adopted by Westinghouse Electric and Manufacturing Co., Carnegie Steel Co. and many other third rail systems. It is pronounced by engineers the most perfect insulator ever made for third rail service. It is made to suit all requirements and all size rails.

Break Down Test of Manhattan Third Rail Insulator

Insulator	1	dry	13,000	Volts	Alternating	Current
"	2	"	"	"	"	"
"	3	"	"	"	"	"
"	1	wet	10,000	"	"	"
"	2	"	"	"	"	"
"	3	"	"	"	"	"

Leakage of Current at 530 Volts D. C.

Insulator	1	dry	No current		
"	2	"	"	"	
"	3	"	"	"	
"	1	wet	10	Milliamperes	
"	2	"	"	"	
"	3	"	"	"	

The above electromotive forces were applied to the insulators without causing them to break down.

Underground Conduit

We have one of the largest and best equipped factories with improved machines for conduit making.

The "Standard" single duct is self-centering.

The "Standard" multiple duct embodies new patent features for rapid construction.

Catalogue on request.

A Physical Test of "Manhattan" Third Rail Insulator

CHEMICAL AND PHYSICAL LABORATORIES

OF

Dr. CHAS. F. McKENNA,

ANALYSES AND ASSAYS OF ORES, METALS, ETC.
PHYSICAL TESTS OF MATERIALS OF CONSTRUCTION AND TECHNICAL WORK.
EXAMINATIONS OF CHEMICAL AND METALLURGICAL PROCESSES.
CONSULTATIONS AND REPORTS IN GENERAL TECHNOLOGICAL AND TECHNICO-LEGAL PRACTICE.

221 PEARL STREET, Cor. Platt.

Certificate of Test.

Laboratory No. 30477. *New York,* Nov. 29th, 1902.

The Standard Vitrified Conduit Co.,
#39 Cortlandt St., New York.

CRUSHING TEST OF THIRD-RAIL INSULATOR.

Size: - - About 5" square, with rounded corners; height, 4". Fitted to Iron Stool, as provided for it, and subjected to crushing stress while resting on this, the Insulator supported a load of 51,000 lbs., or 25-1/2 tons, before breaking.

Respectfully,

CPM-S

STANDARD VITRIFIED CONDUIT CO.

39-41 Cortlandt Street, New York

R. W. LYLE, President and General Manager **B. S. BARNARD, Vice-President and Secretary**

AMERICAN Conduit Co.

Manufacturers of

Bituminized Fiber Conduit

(PATENTED)

For Underground Electrical Work

OUR CONDUIT IS.....

- ELECTROLYSIS-PROOF
- NON-ABRASIVE
- MOISTURE-PROOF
- NON-CORROSIVE
- CHEAPLY and RAPIDLY LAID

INSULATION TEST 66,000 VOLTS

It gives a perfect joint, which is self-aligning and makes each duct a continuous tube from manhole to manhole.

AN IDEAL CONDUIT APPARENTLY EVERLASTING.

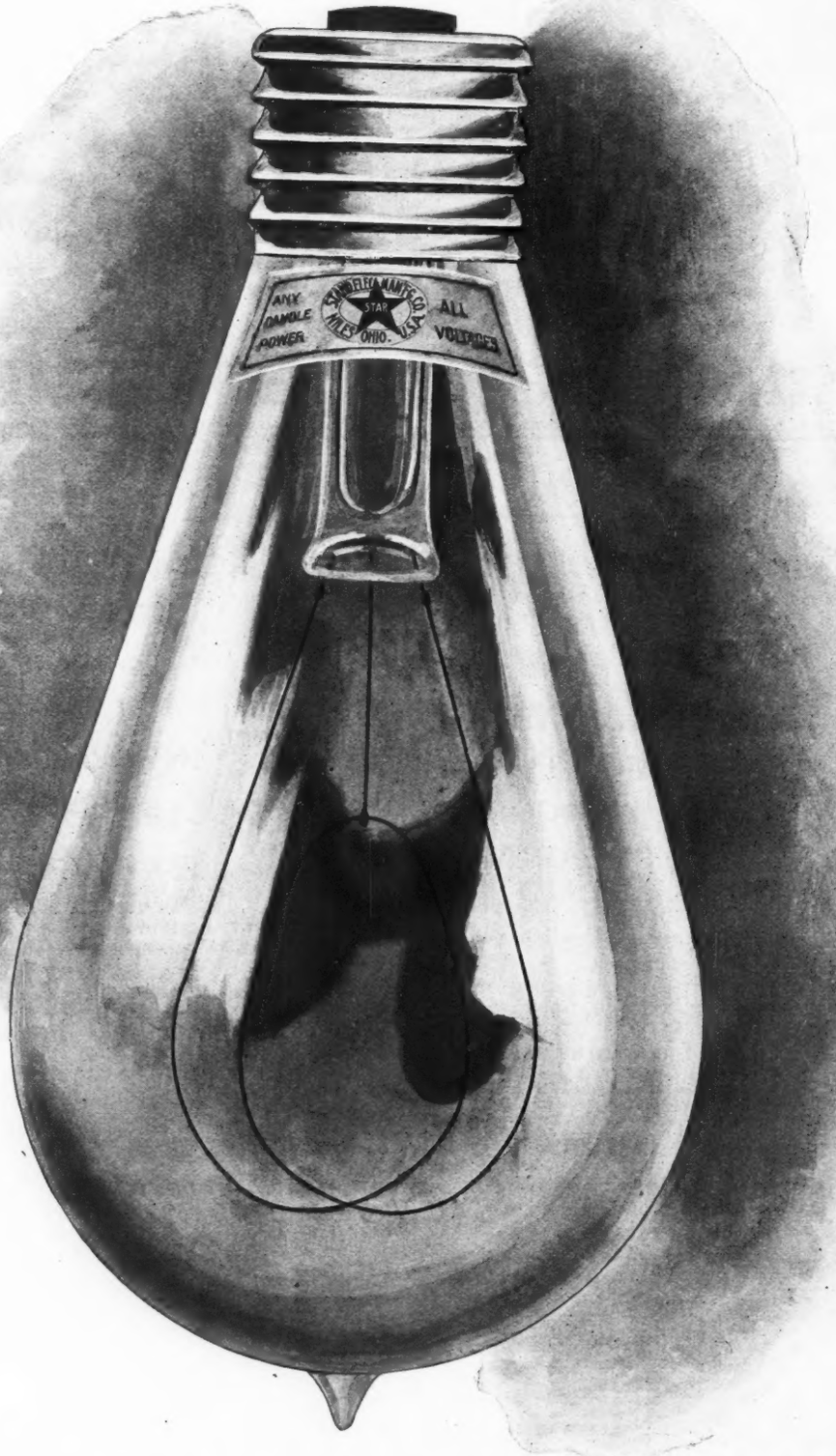
It will pay all those interested in subway construction to write us for particulars and prices before closing contracts for Conduit. State sizes and quantity desired.

Send for our 32-page illustrated 1903 descriptive book.

OFFICES	Factories
720 Arcade Bldg., PHILADELPHIA, PA.	CHESTER, PA.
822 Manhattan Bldg., CHICAGO, ILL.	CHICAGO, ILL.
336 Macy Street, LOS ANGELES, CAL.	LOS ANGELES, CAL.

Be Sure This Label ANY CANDLE POWER — STANDARD ELEC. MANF'G CO. STAR NILES OHIO. U.S.A. — ALL VOLTAGES **Is on Your Lamps**

All Voltages Any Candle Power



Highest Efficiency Long Life Economy

THIS LAMP WILL SPEAK FOR ITSELF

Standard Electrical Mfg. Co.

NILES, OHIO

Imperial Double Filament Lamps

Written guarantees that these lamps are higher than the next best in useful Candle Hours by 13%. This means 13% better sustained candle-power, 13% longer life, 13% less lamps to buy.

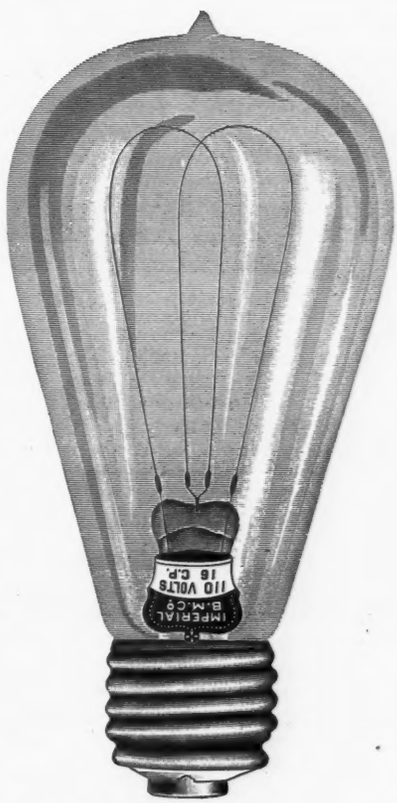
The higher price is economically cheap, as the excess guarantees are double the excess price.

Representative Stations use our lamps. We supply the Oval-Anchored type at competing prices, but we recommend Double-Filament.

Imperial Inner Globes for Arc Lamps.

Highest quality.

No imperfections in grinding, dimensions, weight or uniformity.



Bryan-Marsh
Double Filament
Type.
The Standard
American Lamp
where *results* are wanted.

BRYAN-MARSH COMPANY

NEW YORK	CHICAGO	MINNEAPOLIS	CINCINNATI	SAN FRANCISCO
136 Liberty Street	510 Fisher Building	1112 Lumber Exchange	50 Perin Building	Mills Building

FACTORY, MARLBORO, MASS.

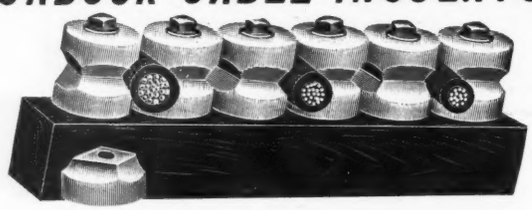
Here's to the T=H Boys of the early days!

Only 20 years since some of us started together.
Sorry the electrical business has grown so slowly!

Twice 20 more years of prosperity to you!

GEORGE CUTTER
UNION AND FULTON STREETS, CHICAGO

MURDOCK CABLE INSULATOR



PAT. SEPT. 17TH, 1901.
Simple, Strong and Cheap.
Size A Holds and Fits all sizes cables from 300,000 to 1,000,000 C. M.
Size B No. 00 to 300,000 C. M.
85,000 Sold.
YOUR DEALER CAN SUPPLY YOU OR ADDRESS
H. D. Murdock, Station D, Pittsburg, Pa.
C. S. KNOWLES, BOSTON, MASS., EASTERN AGENT.

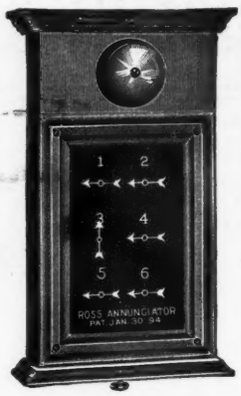
Ross Annunciator

THE BEST ON THE MARKET
IN USE EVERYWHERE

Handsome cases in many styles

Well made by first-class mechanics

Can be furnished with automatic and electric setback attachment



No adjustment of drops is necessary, and they will not shake down under the severest test

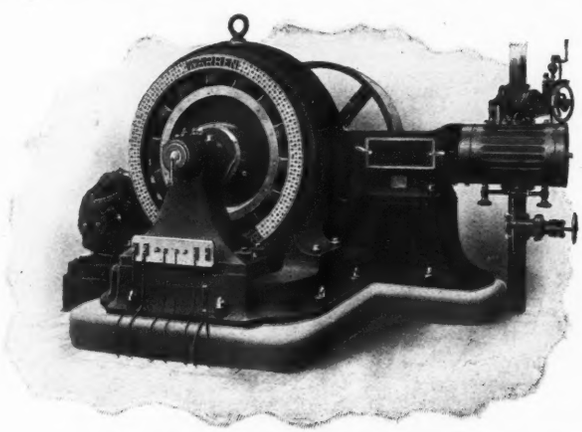
Minimum battery power required

The Ross Telephone Annunciator is the most up-to-date Method for Hotel Use

MANUFACTURED BY
ELECTRIC E GAS G BOSTON LIGHTING L MASS. COMPANY C
FOR SALE BY ALL JOBBERS

ANNUNCIATOR CATALOGUE UPON APPLICATION

ISOLATED PLANTS AND CENTRAL STATIONS



Direct-Connected Warren Alternator

Complete Equipments

Generators and Motors for Direct and Alternating Current Transformers

Arc Lamps — Supplies — Tools

Construction Material

WESTERN ELECTRICAL SUPPLY CO.

ST. LOUIS, U. S. A.

Any Reasonable Load and Speed

TELPHERAGE

Electrical Transporting Elevating and Handling All kinds of Material

DATA

Load with bucket three tons.

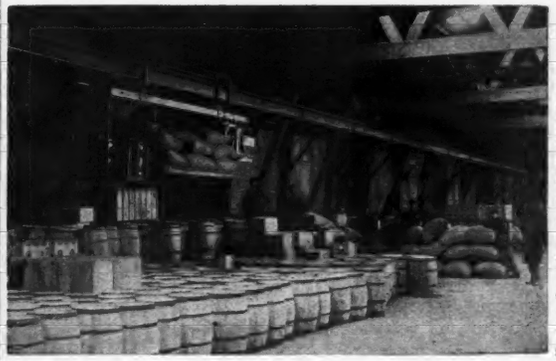
Speed 1,000 feet per minute Applicable to **Coal, Sand, Gravel** and like devisable material.

Telpher for conveying.

Electric Hoist for raising, lowering, opening and closing Clam Shell Bucket.

Telpher replaces eighteen men.

Dumping into hoppers above roof. Long loop line. Curves with grades. Under perfect control of operator in enclosed cab.



Miscellaneous freight, from pier to warehouse. Elevates from floor and conveys. Floor clear for merchandise. Minimum head room hoist.

Applicable to the handling of miscellaneous freight of all kinds, for Railway Companies, at Terminal Stations, for Steamship Companies, on wharves, piers, docks, for Warehouse and Storage Companies, either upon the piers, or between the steamships and warehouses.

SEND FOR GENERAL CIRCULARS

Circulars having special reference to the above issued early in February.

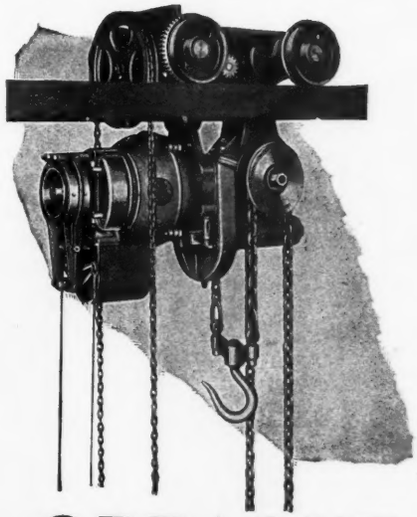
Address **UNITED TELPHERAGE COMPANY**

20.22 Broad Street, NEW YORK, U. S. A.

On the Pacific Coast . . .

"I saw three copies of the ELECTRICAL REVIEW," said a salesman who calls on the electric lighting industry, "to one of any other electrical journal. Our advertisement in the ELECTRICAL REVIEW aided me in my work as they knew us through it before I called on them."

SPRAGUE ELECTRIC HOISTS



THESE HOISTS HAVE BEEN INSTALLED

in many of the large steel plants and have materially assisted in increasing the output of machine tools. Unlike the traveling crane, they are built to handle the product in small units, thus keeping machines free from accumulated work.

600 to 10,000 lbs. capacity. Lifting speed 10 to 64 feet per minute. Traversing speed 200 to 600 feet per minute. Single and double-track trolley carriages—hand operated and motor driven. Write for Bulletin 2096.

WE ALSO MAKE FOUNDRY HOISTS

SPRAGUE ELECTRIC COMPANY

GENERAL OFFICES: 527-531 West 34th Street, New York

BRANCH OFFICES

CHICAGO: Fisher Building BOSTON: Weld Building ST. LOUIS: Security Building BALTIMORE: Maryland Trust Building PITTSBURG: House Building

The ELECTRICAL REVIEW has received many letters complimenting it on its growth and excellence. We quote from one, written under date of January 16, 1903, by one of the ablest electrical engineers of this country:

"Let me congratulate you on the capital New Year Number. The ELECTRICAL REVIEW has always had a distinct flavor of its own that I have enjoyed, and never more so than now."

The ELECTRICAL REVIEW is now in its twenty-second year, and was the first electrical weekly established in America.

Growth of the ELECTRICAL REVIEW in Two Years

FOR THE YEAR 1900

Number of Reading Columns published .	4,152
" " Advertising " " .	6,992

FOR THE YEAR 1902

Number of Reading Columns published .	5,370
" " Advertising " " .	9,400

SUMMARY

This shows a Gain in Reading Space for 1902 over 1900, of . . .	1,218	columns
A Gain in Advertising Space of . .	2,408	columns

Elevator Earnings *for* Central Stations

In its Bulletin for December, 1902, the Edison Electric Illuminating Company of Brooklyn gives the following table. It shows the average monthly earnings of the company, for the past year on 25 electric passenger elevators and 25 electric freight elevators.

PASSENGER ELEVATORS				FREIGHT ELEVATORS		
No.	H. P.	Cost per Month		No.	H. P.	Cost per Month
1	7½	$ 8.64		1	5	$ 5.52
1	7	17.98		1	7	4.32
1	8	21.59		2	20	22.93
1	7½	34.26	**COST OF RUNNING PASSENGER ELEVATOR**	1	5	8.86
1	5	10.95		1	7½	2.88
1	7½	10.37	Average cost per month per passenger elevator $17.33	1	5	5.40
1	6	31.47		1	5	24.28
1	12	12.19		1	7½	7.89
1	7½	15.74	Average cost per month per H. P. $1.98	1	5	1.80
1	15	48.22		1	10	4.68
1	12	31.53		1	7½	3.96
1	5	24.55		1	7½	4.32
1	7½	15.36		1	7½	32.26
1	6	7.24	**COST OF RUNNING FREIGHT ELEVATOR**	1	5	5.72
1	6	5.64		1	7½	5.40
1	6	4.92	Average cost per month per freight elevator....$10.21	1	7½	2.40
1	5	14.50		2	20	25.85
1	15	22.94		1	7½	8.86
1	12	23.51		1	10	29.16
1	7½	5.16	Average cost per month per H. P. $1.37	1	4	9.29
1	10	8.32		1	7½	20.16
1	8	9.98		1	10	13.15
1	15	20.58		1	7½	6.27
1	10	4.80				
1	10	22.93				
25	218	$433.37		25	186	$255.36

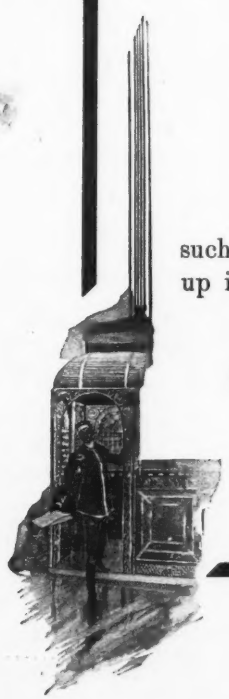
A few years ago, Central Stations rarely enjoyed earnings from such a source, but it is obvious that a large income can be worked up in this field.

For further information, details, etc., address

Otis Elevator Company

71 Broadway, New York City

Branch Offices throughout the Country.



Many uptown residences in New York City are being brought up to date. In such cases an automatic electric elevator is invariably added, the facility with which this elevator can be installed in an existing structure being a factor in making the improvement. In upper Fifth Avenue and the adjacent side streets there is more than one block in which every house has an Otis automatic electric elevator.

Lillibridge, N. Y., 28-846

Concerning Wattmeters

APPEARANCE

A good appearance is often a man's only asset. With this alone he can sometimes succeed, but it's usually in a shady business. But—to a good appearance add a trained mind, a sound body and an honorable disposition and a man will succeed in any business.

Type K Integrating Induction Wattmeters have a good appearance—this makes them more likable to the consumer—but they are also correctly designed and of good, sound, sensible construction.

Is it not so?

The interior construction of a Wattmeter vitally affects its reputation. The compactness and symmetry of the arrangement of the internal parts of Type K Wattmeters has made them great favorites with the men who care for them—the inspector and the repairman. The consistent manner in which they perform their part in the central station business has made them equally popular with the manager.

BULLETIN 1017 TELLS ABOUT THE METER

Ft. Wayne Electric Works

Manufacturer of "Wood" Systems

Main Office and Factory FT. WAYNE, IND.

126

INDEX TO ADVERTISERS.

A

Adams-Bagnall Electric Co.....
Akron Electrical Mfg. Co..... 46
Allen & Co., L. B..... 59
Allis-Chalmers Co..... 65
Alphaduct Mfg. Co..... 59
American Battery Co..... 50
American Bell Telephone Co..... 12
American Carbon & Battery Co..
American Conduit Co. 18,29
American District Steam Co..... 66
American Electrical Heater Co.... 12
American Electric Telephone Co... 71
American Electrical Works..... 1
American Engine Co..... 64
American Insulated Wire & Cable Co..... 76
American School of Correspondence at Armour Institute of Technology.....
American Vitrified Conduit Co.... 19
Arnold Electric Power Station Co. 14
Ashcroft Mfg. Co.....
Atlantic Insulated Wire & Cable Co. 62
Atwater Kent Mfg. Works..... 71
Audel & Co., Theo.....
Automatic Electric Co..... 71

B

Babcock & Wilcox Co..... 63
Baker & Co. 50
Baker, Jos. B..... 14
Ball & Wood Co..... 65
Banner Electric Co..... 12
Barnes Co., The Wallace.....
Barron & Co., Jas. S.....
Barstow, W. S..... 14
Bates & Bro., J. L..... 24
Bell Telephone Mfg. Co..... 72
Benjamin, Geo. H..... 62
Biddle, James G..... 59
Big Four R. R..... 63
Billings & Spencer Co.....
Bishop Gutta-Percha Co..... 1
Blake, M. J. & M..... 63
Bossert Electric Construction Co.. 10
Boston Electric Co..... 59
Brady, T. H..... 62
Bridgeport Brass Co..... 1
Bristol Co. 1
Brookfield Glass Co..... 39
Browning Mfg. Co..... 68
Bryan-Marsh Co..... 31
Bullock Electric Mfg. Co..... 1,68
Bunnell & Co., J. H 4
Burnley Battery & Mfg. Co 12

C

Camp Co., H. B. 18
Cary Spring Works..... 37
Case Bros 59
Central Electric Co..... 3
Chicago Edison Co..... 46
Chicago Fuse Wire Mfg. Co..... 62
Chicago Insulated Wire Co..... 76
Christensen Engineering Co..... 47
Cleveland Armature Works..... 70
Coho & Co., H. B..... 46
Coleman Mfg. Co., The..... 27
Collyer Insulated Wire Co..... 10
Colonial Electric Co..... 25
Columbia Incandescent Lamp Co.
Columbia Electric & Mfg. Co..... 62
Consolidated Engine-Stop Co.... 64
Consolidated Railway Electric Lighting & Equipment Co..... 27
Consolidated Safety Valve Co..... 59
Consumers' Carbon Co..... 16
Continuous Rail-Joint Co. of America..... 15
Crescent Insulated Wire and Cable Co..... 76
Crocker-Wheeler Co.. 69
Crouse-Hinds Electric Co 39
Cutler-Hammer Mfg. Co..... 15
Cutter Co... 1,15
Cutter, George..... 32

D

D. & W. Fuse Co..... 3
De Veau Telephone Mfg. Co.. ... 72
Dickey Sutton Carbon Co..... 4
Diehl Mfg. Co..... 26
Dixon, Jos., Crucible Co..... 10
Donnelly, John..... 62
Doubleday-Hill Electric Co.....
Driver-Harris Wire Co.....

D

Duncan Electric Mfg. Co..... 7
Dustin Co., Chas. E..... 61
Duval, E. S., Jr..... 62

E

Eastern Electric Cable Co..... 10
Eck Dynamo & Motor Works....26,46
Economical Electric Lamp Co ... 19
Edison Decorative & Miniature Lamp Department.....50,73
Edison Mfg. Co..... 15
Electric Appliance Co..... 1
Electric Contract Co..... 5
Electric Gas Lighting Co..... 32
Electric Storage Battery Co..... 37
Electric Launch Co..... 63
Electrical Engineer Institute of Correspondence Instruction..... 62
Elwell-Parker Electric Co..... 47
Empire Wire Co..... 76
Ericsson Telephone Co..... 76
Eureka Electric Color Co..... 62
Eyanson & Co., Geo. T..... 15

F

Farr Telephone & Construction Supply Co. 71
Feilden Publishing Co., Ltd..... 14
For Sale.....
Fort Wayne Electric Works..... 36
Fostoria Incandescent Lamp Co... 43
Fowler, John H..... 71
Frink, I. P..... 41

G

General Electric Co..... 22
General Incandescent Arc Light Co. 26
Gest, G. M..... 16
Gould Storage Battery Co..... 3
Graton & Knight Mfg. Co..... 60
Green Fuel Economizer Co..... 40

H

Hanchett, Geo. T..... 14
Hancock Inspirator Co .....
Hartford Steam Boiler Inspection & Insurance Co..... 63
Hart & Hegeman..... 41
Hart Mfg. Co..... 7
Hawes & Gray..... 62
Hayden & Derby Mfg. Co.....
Hazard Mfg. Co..... 10
Helios-Upton Co..... 6
Hill, W. S., Electric Co..... 15
Hobart Electric Mfg. Co..... 1
Hunt Co., C. W..... 62
Hunter Fan & Motor Co..... ...16,24

I

Incandescent Electric Light Manipulator Co..... 12
India Rubber & Gutta Percha Insulating Co..... 10
International Correspondence Schools..... 17
Inventive Age Publishing Co..... 59

J

Jandus Electric Co..... 2
Jeffrey Mfg. Co..... 63
Jewell Electrical Instrument Co.. 37
Johns-Manville Co., H. W..... 13
Johnson, Chas. F..... 60
Jones & Son, J..... 27

K

Kellogg Switchboard and Supply Co..... 73
Keystone Electric Co..... 46
Keystone Electrical Instrument Co. 1,15
Kinsman Electric and Railway Supply Co..... 48
Klein & Sons, Mathias..... 71
Knott Apparatus Co., L. E..... 59

L

Laird & Lee.....
Lamp Testing Bureau..... 59
Leffel & Co., James..... 44
Lindsley Brothers Co..... 71
Locke, Fred M..... 15
Lombard Governor Co..... ... 44
Lowell Model Co 59
Lunkenheimer Co..... 76
Lyndon, Lamar..... 14
Lyon Metallic Mfg. Co..... 12

(Continued on page 40.)

WHITNEY INSTRUMENTS

THE POCKET VOLT AND AMMETERS

of the WHITNEY make are thoroughly accurate and reliable. They are built on the same principle as standard portable meters with powerful permanent magnets, jewel bearings, etc., and are hand calibrated throughout.

Telephone, battery and signal inspectors find them invaluable.

STANDARD RANGES

Voltmeters—3 to 15 Volts
Ammeters—.15 to 5 Amperes

List Price, this range, $11

Send for prices and catalogue to

MACHADO & ROLLER

(General Sales Office of Whitney Elect. Instrument Co.)

203 BROADWAY NEW YORK, N. Y.

ANYTHING IN REFLECTORS

If you don't find what you require listed in our Catalogue, send us your specifications and we can make it.

We are the Largest Manufacturers

WHEELER REFLECTOR CO.

156 PEARL STREET, BOSTON
Foreign Department, 88 Maiden Lane, New York City

Voltmeters, Ammeters, and Volt-Ammeters . . .

POCKET SIZE,
VARIOUS RANGES.
ACCURATE,
RELIABLE.

For General Measurements, Testing Storage and Primary Batteries, Circuits, Etc.

L. M. PIGNOLET,

Manufacturer of ELECTRIC INSTRUMENTS, and ELECTROTHERAPEUTIC APPARATUS.

78 Cortlandt Street, New York.

Glass Tubing

ALL DIAMETERS
HEAVY WALLS

FOR INSULATING PURPOSES

FOR HIGH VOLTAGE

Made by **The Pairpoint Corp.**

Operating Mt. Washington Glass Co.

NEW BEDFORD, MASS.

JEWELL INSTRUMENTS

For Direct Current only, are used by discriminating engineers

Illuminated Dial Instrument

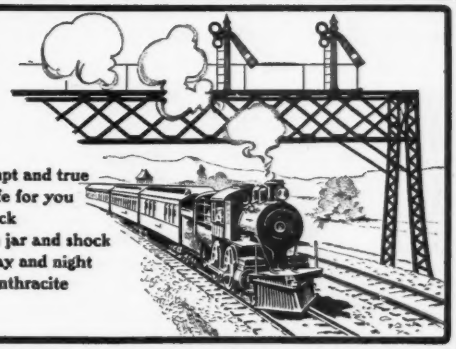
The Illuminated Dial Switchboard Instruments are built in iron cases and have rear connections, ½ inch in diameter and 3½ inches long. Adjustable dials operated by micrometer screw.

Jewell Electrical Instrument Company

61 and 63 Union Park Court, cor. Carroll Ave. - - Chicago, Ill., U. S. A. (2)

Lackawanna Railroad

THIS IS THE ROAD OF ANTHRACITE



These are the signals prompt and true
That make the journey safe for you
Over the bed of ballast rock
That keeps the trains from jar and shock
That smoothly run both day and night
On the dustless Road of Anthracite

ALL SIGNALS OPERATED EXCLUSIVELY BY

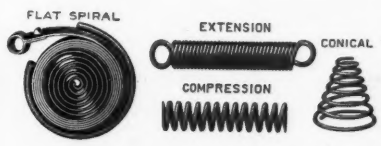
EDISON PRIMARY BATTERIES

Formerly Known as Edison-Lalande.

FULL DESCRIPTION IN BOOKLET NO 17

EDISON MANUFACTURING COMPANY

Factory, ORANGE, NEW JERSEY, U. S. A. New York Office, 83 CHAMBERS STREET
Chicago Office, 144 WABASH AVENUE



Cary Spring Works

240 & 242 West 29th St.
NEW YORK CITY

Manufacturers of

Wire and Springs

For Machinery, Motors, Clocks, Music Boxes and all kinds of Electrical Purposes

THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA

MANUFACTURER OF THE

"Chloride Accumulator"

For Central Stations, Electric Railways, Isolated Lighting and Power Stations, Fire Alarm, Telegraph, Train Lighting, etc. etc.

PRICE LISTS AND DESCRIPTIVE BULLETINS FORWARDED UPON REQUEST

— SALES OFFICES —

PHILADELPHIA Allegheny Ave. & 19th St. | NEW YORK: 160 Broadway | BOSTON 60 State Street | CHICAGO Marquette Bldg. | BALTIMORE: Continental Trust Bldg. | ST. LOUIS: Wainwright Bldg. | SAN FRANCISCO Nevada Block | CLEVELAND New England Bldg. | DETROIT: Michigan Electric Co. | HAVANA CUBA: G. F. Greenwood, Manager 34 Empedrado Street

O-M
ENCLOSED ARC LAMPS

FOR ALL CIRCUITS

ALTERNATING - DIRECT - INTERCHANGEABLE

IF IT'S O-M IT'S O. K.

HIGH EFFICIENCY

WEATHER-PROOF COPPER CASE

SIMPLE IN MECHANISM

ECONOMICAL

Showing Frame and Mechanism. 110-Volt Direct Current.

Direct-Current Constant-Potential Enclosed Arc Lamp for 220 Volts.

Showing Frame and Mechanism, Alternating and Interchangeable.

ALL PARTS EASILY ACCESSIBLE

FLEXIBLE CABLE CARBON CONTACT

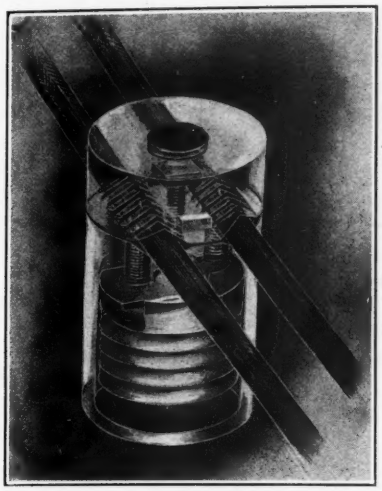
CAN BE USED FOR INTERIOR OR EXTERIOR SERVICE

SEND FOR LATEST BULLETINS

THE OSBORN-MORGAN CO.

560-570 CASE AVE., CLEVELAND, OHIO

Norbitt Specialties



This cut shows the Norbitt Temporary Decorative Socket. Can be used in multiple on 250 volts or in series on 600 volts. Easily and quickly installed.

Crouse-Hinds Electric Co.

Syracuse, New York, U. S. A.

Complete Stock at all Branch Stores

NEW YORK BOSTON CHICAGO
CINCINNATI SAN FRANCISCO

3478

YES

There are other railroads between the east and the west

BUT

it is always well to secure the best you can for the money

THEREFORE

You should bear in mind this remark of an experienced traveler:

"For the excellence of its tracks, the speed of its trains, the safety and comfort of its patrons, the loveliness and variety of its scenery, the number and importance of its cities, and the uniformly correct character of its service, the New York Central & Hudson River Railroad is not surpassed by any similar institution on either side of the Atlantic."

Send to George H. Daniels, General Passenger Agent, Grand Central Station, New York, a 2-cent stamp for a 52-page illustrated Catalogue of the "Four-Track Series."

PANEL BOARDS,

CABINETS, LININGS, Etc.

Send for Catalogues, Bulletins and Dimension Sheets

Special Selling Agents: FRORUP & LEVY, 232 Greenwich St., N. Y.

ZIMDARS & HUNT

52-54 Grove St., 127 Fifth Ave., NEW YORK

BROOKFIELD

SCREW-GLASS

FOR HIGH VOLTAGE

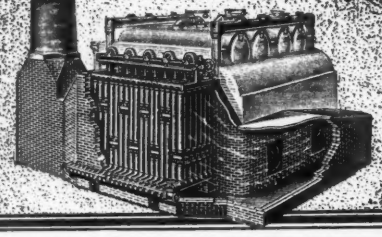
INSULATORS

We develop and manufacture special designs of all types of insulators to meet all requirements for high voltage transmission. Correspondence Invited

Brookfield Glass Co., New York

GREEN'S ECONOMIZER

SAVES 10 TO 20% IN FUEL



An item worth considering at the present price of coal

Special designs for ELECTRIC LIGHT and POWER PLANTS

See our free booklet "Green's Economizer" for detailed information

THE GREEN FUEL ECONOMIZER COMPANY

MATTEAWAN, N. Y.

Sole manufacturers in the U. S. A.

ALPHABETICAL INDEX.—(*Continued from page 36.*)

M

Machado & Roller 37
Marshall, Wm. 60
Marshall-Sanders Co. 19
Massachusetts Chemical Co. 9
McGill University 63
McIntire Co., The C. 62
McTighe, Thos. J. 14
Mechanical Boiler Cleaner Co. 65
Menchen, Joseph P. 48
Mica Insulator Co. 50
Michigan Central R. R. 63,65
Monarch Fire Appliance Co 50
Montauk Fire-Detecting Wire Co. 1
Morse Twist Drill Co. 65
Munsell & Co., Eugene. 32
Murdock, H. D. 16
Murdock Parlor Grate Co. .....

N

National Battery Co 6
National Carbon Co. .....
National Conduit & Cable Co. 1
National India Rubber Co 1
Nernst Lamp Co. 74
New England Butt Co. 15
New England Engineering Co. 5,14
New England Motor Co. 46
New York & Ohio Co. .....
New York Cen. & Hudson Riv. R. R. 39,63
New York Insulated Wire Co. 1
New York Telephone Co. 72
North Electric Co. 72

O

Okonite Co. 1,11
Osborn-Morgan Co. .....
Osburn Flexible Conduit Co. 1
Ostrander, W. R. & Co. 63
Otis Elevator Co. 35

P

Pacific Electric Co. 7
Paiste Co., H. T. 16,37
Parsell & Weed. 59
Peerless Electric Co. 20,21
Pennsylvania R. R. 16,71
Phelan, D. W. 71
Phœnix Glass Co. 1
Phelps Co. 13,59
Phillips, Eugene F., Bare and Insulated Wires 1
Phillips Insulated Wire Co. 76
Pignolet, Louis M 37
Portland Co., The 46
Power Installation Co. 14
Powers Co., The E. L. 14
Prentiss Clock Improvement Co. .. 16
Pullen Electric Co., Leon W. 62

R

Rae, Frank B. 14
Rappel, E. F. P. 62
Reuterdahl, Arvid. 14
Reuterdahl Electric Co. 7
Risdon-Alcott Turbine Co. 44
Rittenhouse-Miller Co. 16
Robbins & Myers Co 23
Roberts Electric Supply Co., H. C 16
Robertson & Sons, Jas. L 59
Roche, William. 70
Roebling's Sons Co., John A. 76
Rooney-Westbury Elec. Lamp Co .
Rossiter, MacGovern & Co. 60
Royal Electric Co. 46
Runyon, F. O. 14

S

Safety Insulated Wire & Cable Co . 10
Samson Cordage Works 59
Schwerdtle Stamp Co 62
Schlesinger & Mears. 1
Seneca Falls Mfg. Co 63
Sheaff & Jaastad. 14
Shelby Electric Co. 16,65
Siegrist Lubricator Co. 6
Siggers & Siggers. 62
Simplex Electrical Co 1,16
Smith Storage Battery Co. 19
Smith & Hemenway Co 76
Speer Carbon Co. 76
Spencer Electrical Co 72
Sprague Electric Co. 33,50
Standard Electric Mfg. Co. 30
Standard Paint Co. 50
Standard Pole & Tie Co 71
Standard Underground Cable Co.. 1
Standard Vitrified Conduit Co. .. 18,47
Stanley Electric Mfg. Co. 1,45
Stanley Instrument Co 18

(*Continued on page 44.*)

EASY TO TRIM

The A-B Enclosed Arc Lamp

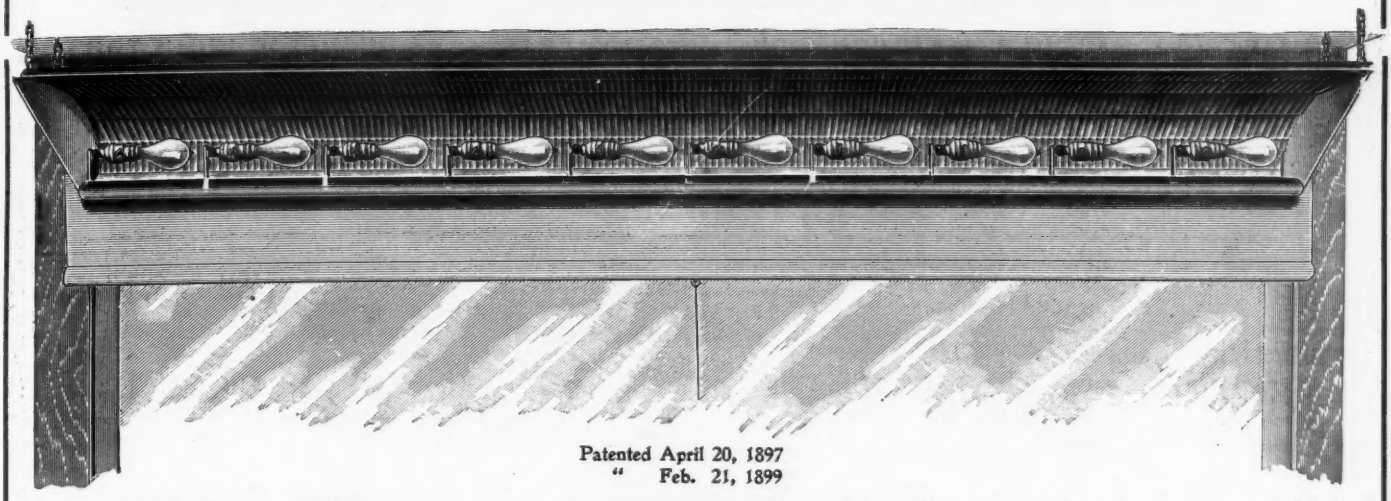
is rapidly being adopted by most of the principal cities for street lighting, because it's strong, handsome, simple and efficient. Made in solid copper or pressed cases for all circuits.

OVER 100,000 IN DAILY USE

Western Electrical Supply Co.

Write us to-day for Descriptive Matter and Prices ST. LOUIS, U. S. A.

Frink's Special Patent Window Reflector



Patented April 20, 1897
" Feb. 21, 1899

THINK FOR A MINUTE

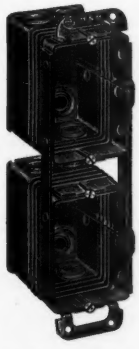
Who are the buyers of this Reflector?

Naturally, the large retail stores. Things they don't want can't be sold them at any price—things they DO want they will pay the right price for. These stores pay thousands each year for newspaper space; they pay good salaries to artistic window dressers; they are liberal, to an extreme, in their expenditures for the sort of advertising that pays. All of them recognize the value of window advertising, and are interested in whatever will increase its efficiency. This is the whole secret of the success contracting engineers are having in installing our window reflector. It needs no argument once it is explained; it commands a good price because it is the best fixture for the purpose; it helps secure large store lighting contracts; it advertises you as well as the store. Send for full particulars and get posted, so that when estimating contracts you can put in a proper bid.

Geo. Frink Spencer
Manager

I. P. Frink 551 PEARL ST., Telephone 860 Franklin **New York**

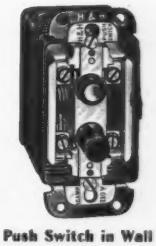
H. & H. WALL CASES



No. 2 Tandem Wall Case

A Great Convenience in Wiring Old Buildings. Regular H. & H. Flush Plates for Push Switches and Rectangular Flush Switches will Cover the Opening

No. 1 Wall Case



Push Switch in Wall Case, no Plate

THE HART AND HEGEMAN MFG. CO.

92 UNION PLACE, HARTFORD, CT.

SOMETHING NEW!

IN LINE WITH THE TWENTIETH CENTURY ADVANCEMENTS OF THE WORLD'S INDUSTRIES

WHEN THE COVERS TO PRACTICAL ELECTRICITY ARE THROWN BACK

The Student, the Steam Engineer, the Practical Man, the Electrical Engineer and the College Professor see therein a new light, illuminating the way to an easy and effective method of studying the art of Electricity. The publishers have on file over four hundred letters, the writers ranging in rank from beginner to noted Electrical Engineers, commenting on the merits of this new work.

BOOK CONTAINS

287 Pages of Subject Matter.

162 Pages Dictionary and Tables.

427 Questions and Answers.

95 Illustrations.

20 Tables (all that's required).

Size 6 x 4¾ inches.

Flexible Binding.

Set in 8-Point Type, a good, readable size.

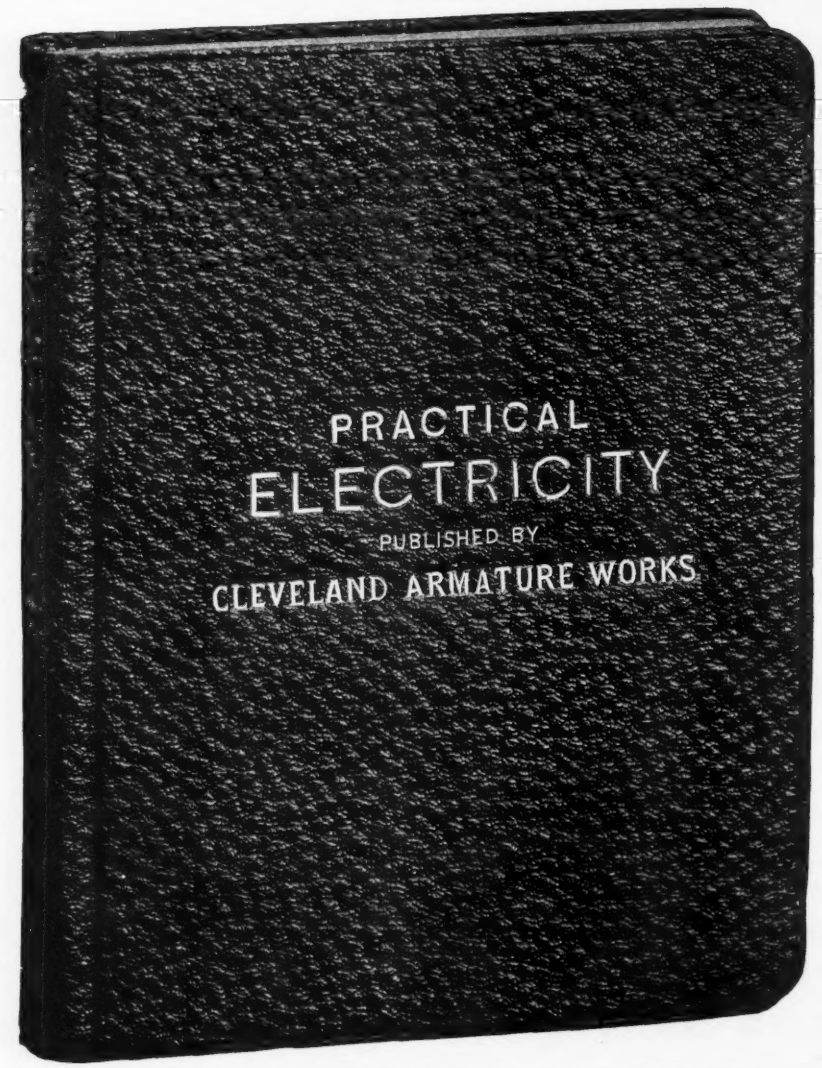


TABLE OF SUBJECTS

CHAPTER

I—Wiring.
II—Electric Batteries. Electric Plating.
III—Magnetism.
IV—The Magnetic Circuit.
V—Magnetic Traction.
VI—Magnetic Leakage.
VII—Energy in Electric Circuit.
VIII—Calculation of Size of Wire for Magnetizing Coils.
IX—Calculation of E. M. F.'S in Electric Machines.
X—Counter E. M. F.
XI—Hysteresis and Eddy Currents.
XII—Armature Reaction.
XIII—Sparking.
XIV—Winding of Dynamos and Motors.
XV—Proper Method of connecting Dynamos and Motors—Self-Excitation.
XVI—Diseases of Dynamos and Motors, their Symptoms and How to Cure Them.
XVII—Arc and Incandescent Lamps.
XVIII—Measuring Instruments.
XIX—Alternating Current.

A Dictionary of over 1,500 Electrical Words, Terms and Phrases, giving a brief meaning of all which are in common use.

EXTRACTS OF A FEW OF THE HUNDREDS OF LETTERS ON FILE

Geo. E. Hanscom, Electrical Department Mare Island Navy Yard, says: "Send two more copies of Practical Electricity. Find this work invaluable. I guess my friends do also as they never let a chance to steal them escape. I am having chains made to attach them to my desk."

Herbert W. Kimble, Electrician, Haverhill, Mass., says: "I saw in Dartmouth College Library a copy of Practical Electricity. I was so much pleased with it I want a copy."

L. D. Burlingame, Pasadena, Cal., says: "In a trip to Arizona I lost my copy of Practical Electricity. I prize the book so highly that I enclose money order for another."

Wm. Hickey, Sec'y Electrical Workers' Union No. 49, Chicago, Ill., says: "This book is a little wonder. Every Question and Answer is given so plainly that any one can understand them. It is not only instructive to beginners, but to those advanced as well."

Camble Courtney, Newry, S. C., says: "I know nothing about Electricity yet your book gives a great deal of valuable information, it is written in such a common sense way."

Lewis P. Osborn, Warden, Idaho, says: "Mr. Livingston, Chief Electrician of the light plant at Bozeman, Mont., gave me a copy of your book while I was in his employ. I lost it in a hotel fire; find money order for another copy."

James H. Kendle, Marine Engineer, Detroit, Mich., says: "I purchased your book from Burrows Bros. of your city. I think so much of the book. I have quite a library of books and have none I think more of than Practical Electricity.

Third Edition. **Price $2.00, Delivered.**

ELECTRICAL REVIEW PUBLISHING CO.

Box 339. **13-21 Park Row, New York.**

FOSTORIA
INNER GLOBES

"THE PERFECT"
FOSTORIA

We offer you a product which is the result of heavy expenditures in experiment upon glass, large investments in special designed grinding machinery and the exclusive attention of the most skilled glass blowers in America, who make the globes and test each one individually before it goes into stock. Get our Catalogues and Lists.

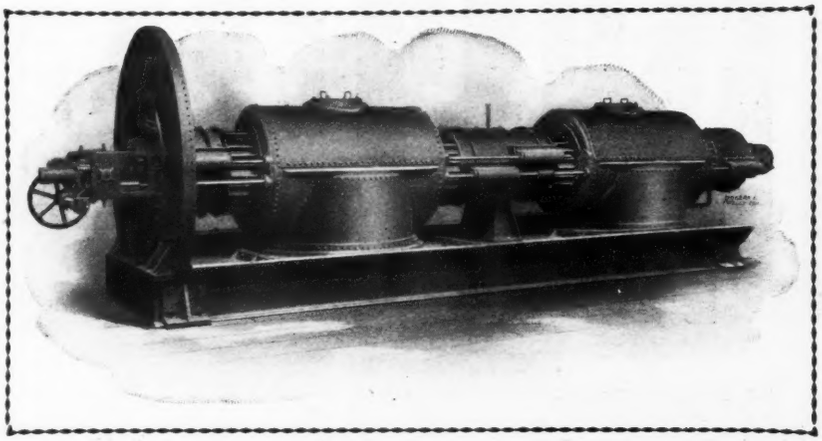
The Fostoria Incandescent Lamp Co.

FOSTORIA . . . . . OHIO

VICTOR TURBINES

For use in
ELECTRIC POWER PLANTS
Built Upright or Horizontal, Single or in Pairs

SPECIAL FEATURES
High Speed and Efficiency
Great Power and Strength
Easy Working Gate and Fine Regulation
Further Particulars Freely Given



We also make
STEAM, POWER and ELECTRIC PUMPING MACHINERY
for
WATERWORKS SUPPLY, FACTORIES, MILLS, MINES, Etc.
JET, SURFACE and COUNTER CURRENT CONDENSERS
and
STILWELL'S FEED-WATER HEATERS

THE STILWELL-BIERCE & SMITH-VAILE CO.
Dayton, Ohio, U. S. A.

NEW YORK, 141 Broadway
BOSTON, 73 Oliver Street
PHILADELPHIA, 619 Arch Street
CLEVELAND, 1116 New England Building
NEW ORLEANS, 304 Hennen Building
CHICAGO, 311 Dearborn Street
BALTIMORE, MD., 1507 Continental Trust Building
SALES AGENT, Frederic Nell, 97 Queen Victoria Street, London, E. C.
E. F. AUSTIN, Smith Block, PITTSBURG. 3

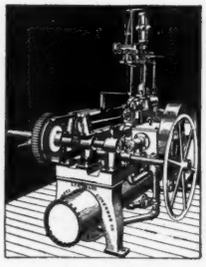
TURBINES
UPRIGHT AND HORIZONTAL
For ELECTRIC POWER and LIGHTING PLANTS

RISDON TURBINE
gives the highest full gate results of any Turbine ever made.

ALCOTT HIGH DUTY TURBINE
High speed and efficiency. Great strength. Close regulation and steady motion.

TAYLOR SLEEVE GATE TURBINE
The largest power ever obtained from a wheel of the same diameter.

RISDON - ALCOTT TURBINE CO.
Write for Catalogue. MOUNT HOLLY, NEW JERSEY, U. S. A.



Type B

OUR
Water Wheel Governors
ARE THE
Standard of the World
Twelve types controlling 400,000 horse-power are in use.
Write for catalogue and list of several hundred plants where they are in use.

The Lombard Governor Co.
36 WHITTIER ST., BOSTON, MASS.

ALPHABETICAL INDEX.
(*Continued from page 40.*)

S

Stanley & Patterson..... 10
Sterling Electrical Mfg. Co..... 13,19
Sterling Varnish Co..... 50
Steward Mfg. Co., D. M..... 16
Stillwell-Bierce & Smith-Vaile Co. 44
Stirling Co..... 63
Storey Motor & Electric Co..... 49
Stow Manufacturing Co..... 68
Stromberg-Carlson Telephone Mfg. Co..... 72
Stuart-Howland Co.....

T

Thistlewhite, R..... 62
Thomas & Sons Co., R..... 12
Thresher Electric Co..... 67
Triumph Electric Co..... 46
Tulley & Co., Henry C..... 7

U

United States Battery Co.....
U. S. Mineral Wool Co. 63
United Telepherage Co..... 33
University of Wisconsin..... 63
Utica Drop Forge & Tool Co..... 76

V

Vail, J. H..... 14
Van Nostrand Co., D.....
Viaduct Mfg. Co..... 71
Vindex Electric Co..... 59
Vought-Berger Co..... 72

W

Wagner Electric Mfg. Co..... 46
Wanted..... 62
Warren Electric Mfg. Co..... 69
Warren Electric & Specialty Co.. 1
Westcott, Geo. F..... 14
Western Electric Co..... 5
Western Electrical Supply Co.. 32,40
Western Telephone Mfg. Co..... 71
Westinghouse Electric & Mfg. Co. 75
Weston Electrical Instrument Co. 50
Wheeler Reflector Co..... 37

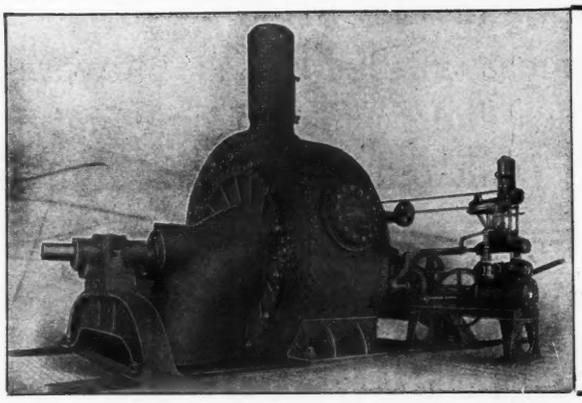
W

White & Co., J. G..... 14
Whitney Electrical Inst. Co..... 37
Wilmerding, C. H..... 14
Wyckoff Creosoting Co..... 50

Z

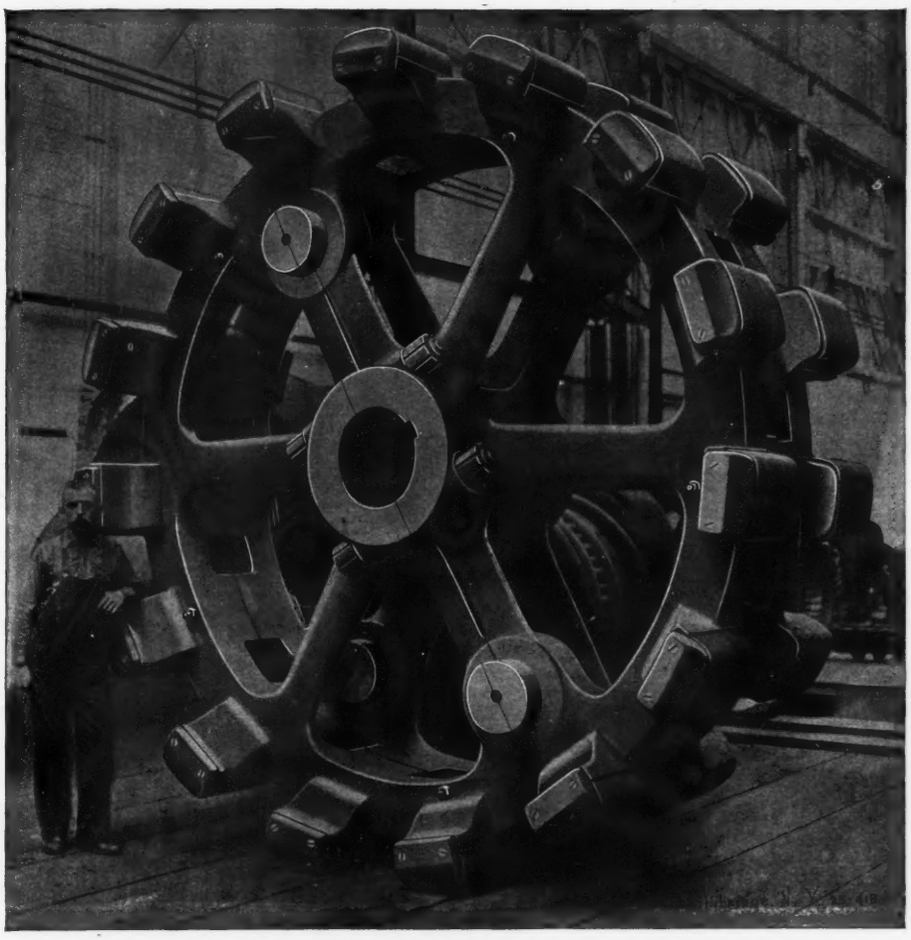
Zimdars & Hunt..... 39

(*Continued on page 48.*)



SAMSON TURBINE
ESPECIALLY ADAPTED TO DRIVE
ELECTRICAL MACHINERY
SPECIAL FEATURES:
High Efficiency at all Gateages
Balanced Gate, Steady Motion
High Speed, Great Strength
These Turbines Allow Exceedingly Close Speed Regulation. Write Dept. V for Catalog.
JAMES LEFFEL & CO., SPRINGFIELD, OHIO U. S. A.

The SKC System



INDUCTOR, OR ROTARY PART OF A 2000-KILOWATT S. K. C. GENERATOR

typifies machinery markedly superior in points of engineering and manufacture over ordinary electrical apparatus. It comprises the latest developments and improvements in generators, transformers, rotary converters, motor-generator sets, switchboard apparatus, etc., and now includes railway equipments and supplies. S. K. C. apparatus is unequaled for its simplicity and reliability.

The Inductor Alternator

FOR generating currents of 60 or more periods per second, the Inductor Type Generator possesses advantages which, where appreciated, give it precedence over every other type of alternating-current machine, including the rotary field type. The practical inductor machine originated in our shops, and to-day the S. K. C. Inductor Generator is the only successful one offered in this country. Abroad our designs have been followed by the oldest and best equipped manufacturers.

The S. K. C. Inductor Type Generator is the simplest form of machine extant, and therefore the least likely to make trouble. The field coil is stationary, the armature is stationary, and there are neither brushes, collectors nor moving wires of any kind. Wear and tear are reduced to the simplest known mechanical movement—a shaft revolving in bearings.

Stanley Electric Mfg. Company

Pittsfield, Mass.

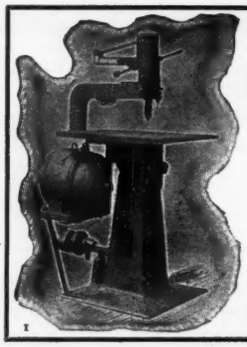
BRANCH OFFICES:

NEW YORK—29 Broadway.
CHICAGO—Monadnock Block.
BOSTON—Equitable Building.
PHILADELPHIA, PA.—26 S. 15th St.
CLEVELAND, O.—129-131 Euclid Ave.
BUFFALO, N. Y.—202 Main St.
DETROIT, MICH.—Michigan Electric Co.
DENVER, COL.—Hendrie & Bolthoff Mfg. & Supply Co.
SAN FRANCISCO—31-33 New Montgomery St.
LOS ANGELES, CAL.—Douglas Building.
ST. PAUL, MINN.—131 East Fifth St.
SEATTLE, WASH.—Pioneer Building.
BUTTE, MONT.—Western Mining Supply Co.
NORTH CAROLINA—Greensboro.
ATLANTA, GA.—Empire Building.

In Canada S. K. C. Apparatus is manufactured by the CANADIAN GENERAL ELECTRIC CO., TORONTO.

Lillibridge, N. Y., 23-1004.

H. B. COHO & COMPANY, INC.
Contracting Engineers
DYNAMOS, MOTORS, STORAGE BATTERIES
Complete Steam and Electrical Equipments
Write for Booklet
114 LIBERTY STREET, NEW YORK



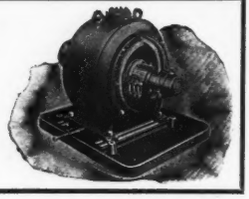
EQUIP YOUR SHOPS ELECTRICALLY
Generators and Motors
ALL SIZES ALL TYPES
TRIUMPH ELECTRIC CO.
Cincinnati, Ohio, U. S. A.
Send for Bulletin "E. R."

MOTORS **GENERATORS**
AKRON ELECTRICAL MFG. CO. AKRON-O.
OPEN OR ENCLOSED FOR POWER PURPOSES
BELTED OR CONNECTED DIRECT FOR LIGHTING PURPOSES
1 TO 600 HP 1 TO 500 KW

BEST ON THE MARKET
THE NEW ENGLAND MOTOR CO.
LOWELL, MASS.

EMPIRE WIRE COMPANY
Manufacturers of
BARE & TINNED COPPER WIRE, MAGNET WIRE
Cable Address, SONGARRI, N. Y.
Lieber Code
"QUALITY"
100 William St., NEW YORK

DYNAMOS and MOTORS
Eck Dynamo and Motor Works
Belleville, N. J., U. S. A.
TRADE MARK

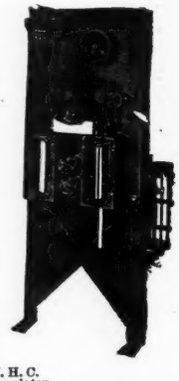


CENTRAL STATION OFFICIALS
All read the ELECTRICAL REVIEW. Ask them.
Advertisers should remember this fact.

TRIUMPH ELECTRIC CO.
CINCINNATI, OHIO, U. S. A.
GENERATORS AND MOTORS

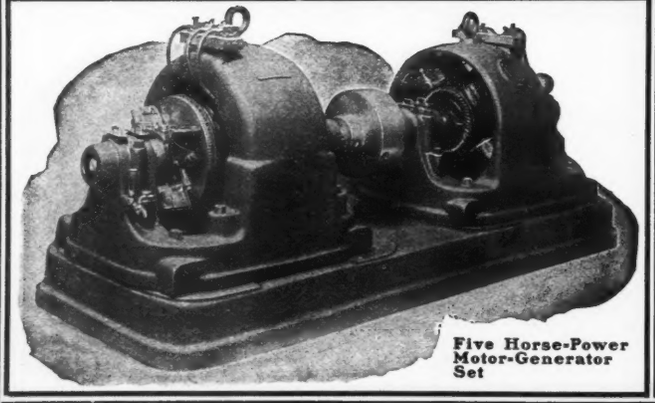
Alternating Current
GENERATORS, TRANSFORMERS AND ACCESSORIES. . . . .
Royal Electric Company
PEORIA, ILL.

THE BEST IS THE CHEAPEST
THE LATEST IMPROVED
Voltage Regulators
OF
W. H. CHAPMAN
Are made under the Inventor's personal supervision by
The Portland Company
PORTLAND, ME.
Incorporated 1846. Send for Circulars and Testimonials



W. H. C. Regulator, Patent May 1, 1900.

CHICAGO EDISON COMPANY
REPAIR SHOPS
76 MARKET STREET, CHICAGO. Telephone, Main 1280
FIRST-CLASS EQUIPMENT IN ALL SHOPS
OPEN DAY and NIGHT • • PROMPT ATTENTION
Dynamos, Armatures, Motors, Arc Lamps, Instruments, Machine Shop; Engines, Etc., Carpenter Shops; Cabinets, Etc.
CORRESPONDENCE SOLICITED



Five Horse-Power Motor-Generator Set

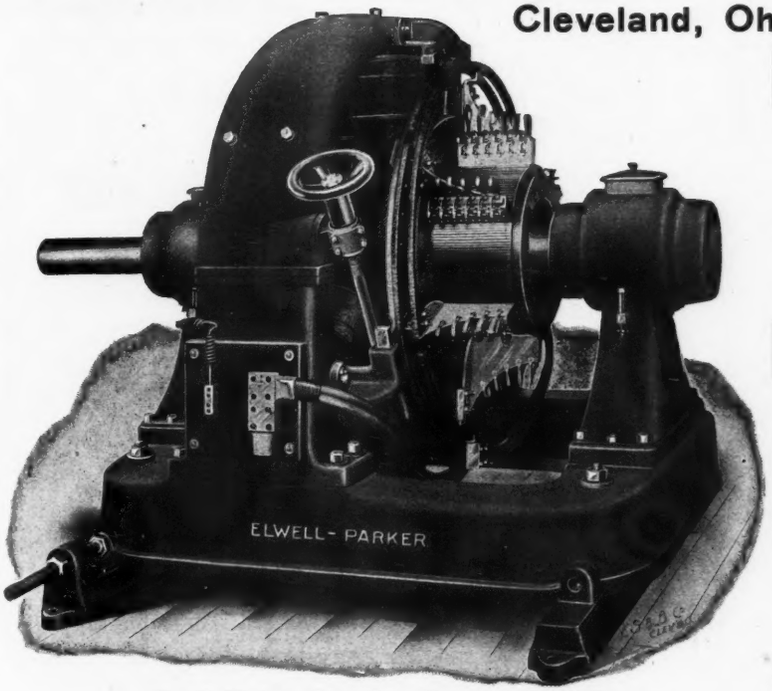
Motor-Generator SETS

consisting of a **Single-Phase, Self-Starting, A. C. Motor** and a **D. C. Generator,** are quite desirable for charging batteries for Telephone Systems. Their automatic features make them particularly desirable in the hands of inexperienced operators. Bulletin 56.

WAGNER ELECTRIC MFG. CO.
St. Louis, Mo., U. S. A.

ELWELL-PARKER ELECTRIC COMPANY

Cleveland, Ohio



Class B. Machine—Large Size. From 1 to 300 H. P.

An Honest Word to the Careful Buyer

It will pay buyers of Motors and Generators and those that are buying electric lighting and electric power plants to investigate what we can furnish them. Our machines are of the very latest electrical and mechanical design

We want you to write us

AUTOMOBILES

A word to our friends who intend building successful electric automobiles:
We have the motor for you. It is the most efficient and the lightest motor, and it will do the best hard work of any you can buy. You can not make it spark or overheat. Hundreds of them in constant service prove these claims.
We manufacture these motors in large quantities by special machinery. All parts are, therefore, interchangeable and very accurately made

We have finished experimenting

NEW YORK OFFICE, 95 LIBERTY ST.

"CECO" ELECTRICAL MACHINERY

DIRECT CURRENT

Motors from 2 H. P. up

Generators up to 1000 K. W.

For Lighting Power and Railway Service

ALTERNATING CURRENT

Generators 37 to 1500 K. W.

"CECO" apparatus is modern in design, accurate in construction and superior in performance

WRITE FOR CATALOGUE No. 26

Christensen Engineering Company

MILWAUKEE, WISCONSIN

Chicago: Merchants' Loan and Trust Building **Pittsburg: Gellatly & Co., Times Building**

THE
"Trade Mark"
INCANDESCENT
ELECTRIC LAMP

The latest improvement in Electric Lighting : : A high-grade, long life, efficient lamp : : : : :

TRADE MARK
LAMP

You do not have to enter into yearly contract to get the quantity price.

We know it has to be a good lamp to get your order, and this is a superior lamp.

Write for our price offer. You will be interested in it.

Kinsman Electric and Railway Supply Co.
91 Liberty Street, N. Y.

CLASSIFIED INDEX

(*Continued from page 44.*)

Adjusters, Incandescent Lamps.
Incan. Elec. Light Manipulator Co.
Pacific Electric Co.
Vought-Berger Co.

Air Compressors.
Stilwell-Bierce & Smith-Vaile Co.

Alternators.
Christensen Engineering Co.
Fort Wayne Electric Works.
General Electric Co.
Warren Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.

Annunciators.
Ohio Electric Works.

Armature Repairs.
Cleveland Armature Works.

Batteries, Primary.
American Carbon & Battery Co.
Burnley Battery & Mfg. Co.
Edison Mfg Co.
Pullen Electric Co., Leon W.
Roche, William

Batteries, Storage.
American Battery Co.
Electric Storage Battery Co.
Gould Storage Battery Co.
National Battery Co.
Reuterdahl Electric Co
Smith Storage Battery Co.

Bells.
Ostrander & Co., W. R.

Belt Dressing.
Dixon Crucible Co., Joseph

Boilers.
Allis-Chalmers Co.
Babcock & Wilcox Co., The.
Stirling Co., The.

Boiler Cleaners.
Mechanical Boiler Cleaner Co.

Boiler Compounds.
Dearborn Drug & Chemical Co.

Boiler Insurance.
Hartford Steam Boiler Insp. & In. Co.

Books, Technical.
Audel & Co., Theo.
E. L. Powers & Co.
Tulley & Co., Henry C.

Brushes-Dynamo.
Speer Carbon Co.

Cable Hangers.
Standard Underground Cable Co.

Cabling Machines.
New England Butt Co.

Carbons.
American Carbon & Battery Co.
Consumers' Carbon Co.
Dickey Sutton Carbon Co.
General Incandescent Arc Light Co.
National Carbon Co.
Speer Carbon Co.

Castings.
Christensen Engineering Co.
New England Butt Co.

Circuit-Breakers.
Cutler-Hammer Mfg. Co.
Cutter Electrical & Mfg. Co.
Fort Wayne Electric Works.
Western Electric Co.

Cleaners, Incandescent Lamps.
Incan. Elec. Light Manipulator Co.

Climbers
Klein & Sons, Mathias.
Smith & Hemenway Co.

Coal Handling Machinery.
C. W. Hunt Co.
The Jeffrey Mfg. Co.

Coal Mining Machinery.
General Electric Co.
The Jeffrey Mfg. Co.

Commutator Lubricant.
Allen & Co., L. B.
Anchor Chemical Co.

Commutator Segments.
Billings & Spencer Co.

Condensers (Electric).
Marshall, Wm.
Wheeler Condenser & Eng. Co.

Conduits.
Alphaduct Mfg. Co.
American Vitrified Conduit Co.
Camp Co., H. B.
Gest, G. M.
National Conduit & Cable Co.
Osburn Flexible Conduit Co.
Rittenhouse-Miller Co.
Sprague Electric Co.
Standard Vitrified Conduit Co.
Wyckoff Creosoting Co.

Connectors
Smith & Hemenway Co.

Connectors and Terminals.
McIntire Co., The C.

Construction.
J. G. White & Co.
New England Engineering Co

Construction Supplies.
T. H. Brady.

Cross-Arms, Brackets, Pins, Ties, Climbers, Etc.
Central Electric Co.
Donnelly, John.
Klein & Son, Mathias.
Lindsley Brothers Co.
Standard Pole & Tie Co.

Dynamos and Motors.
Akron Electrical Mfg. Co.
Bullock Electric Mfg. Co.
Central Electric Co.
Coho & Co., H. B.
Christensen Engineering Co.
Cleveland Armature Works.
Crocker-Wheeler Co.
Dustin Co., Chas. E.
Eck Dynamo & Motor Works.
Elwell-Parker Electric Co.
Fort Wayne Electric Works.
General Electric Co.
Gen'l Incandescent Arc Light Co
Hobart Electric Mfg. Co.
Johnson, Charles F.
Keystone Electric Co.
New England Motor Co.
Robbins & Myers Co.
Rossiter, MacGovern & Co.
Royal Electric Co.
Sprague Electric Co.
Stanley Electric Mfg. Co.
Stow Manufacturing Co.
Thresher Electric Co.
Wagner Electric Mfg. Co.
Warren Electric Mfg. Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Electric Locomotives.
General Electric Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.

Electric Lighters.
Electric Contract Co.
Stanley & Patterson.

Electrical Instruments.
Bossert Electric Construction Co.
Bullock Electric Mfg. Co.
Bunnell & Co., J. H.
Ericsson Telephone Co.
Fort Wayne Electric Works.
Gen'l Incandescent Arc Light Co
Lamp Testing Bureau.
Machado & Rolle..
Pignolet, Louis M.
Wagner Electric Mfg. Co.

Electric Soldering Irons.
American Electrical Heater Co
Simplex Electrical Co.

Electrical Supplies.
Central Electric Co.
Crouse-Hinds Electric Co.
Electric Appliance Co.
Ericsson Telephone Co.
Kinsman Electric & Railway Sup. Co.
Marshall-Sanders Co.
Paiste Co., H. T.
Roberts Electrical Supply Co., H. C.
Schlesinger & Mears.
Stanley & Patterson.
Stewart & Co., Frank H.
Western Electric Co.
Worthington Co., Geo.

Elevating & Conveying Machinery.
Brown Hoisting Machinery Co.
Jeffrey Mfg. Co

Engines (Steam).
Allis-Chalmers Co.
American Engine Co.
Ball & Wood Co.
Dustin, Chas. E.
Johnson, Charles F.
Rossiter, MacGovern & Co.

Engines (Gas).
Lowell Model Co.

Engine Indicators.
Ashcroft Engineering Co.

(*Continued on page 66.*)

Menchen
makes
Attaching Plugs
Open Box Lights
Lens Boxes
Bunch Lights
and all
Special Electrical Equipments
for
Theatrical and Similar Services

Get my Catalogue

JOSEPH P. MENCHEN
1237 Broadway, New York

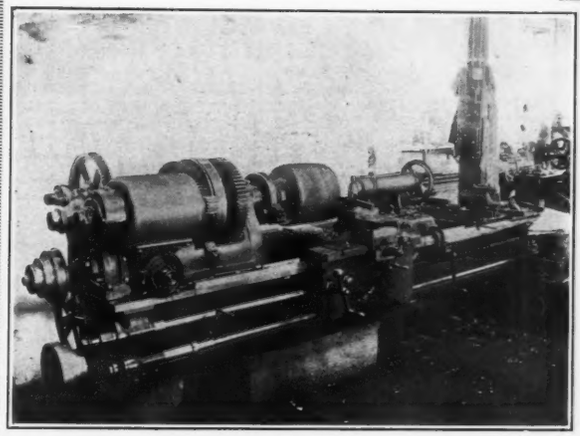
You don't have to perform surgical Operations on

STOREY MOTORS: THEY ARE HEALTHY

70 PER CENT OF THE POWER GENERATED IS DISSIPATED IN BELTING AND SHAFTING.

PURCHASERS WHO MENTION THIS AD. IN THEIR FIRST LETTER WILL RECEIVE AN EXTRA DISCOUNT OF 1% ON PURCHASES MADE WITHIN 30 DAYS.

Successful merchants avoid complications



THE STOREY-FAY VARIABLE SPEED SYSTEM IS THE A B C OF SIMPLICITY

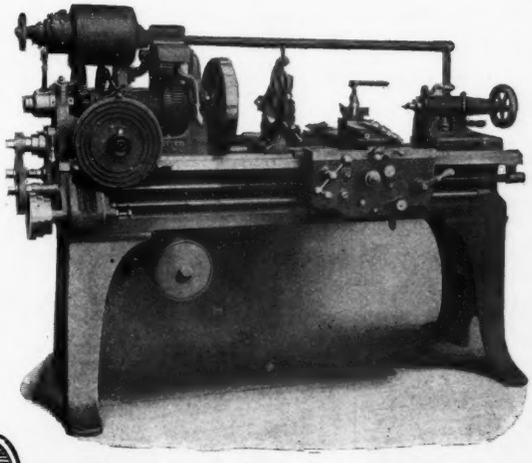
THE DEPRECIATION OF THE BELTING ITSELF IS 16 PER CENT.

STOREY MOTOR AND ELECTRIC CO.

THE BIG FOUR

HARRISON (NEWARK) NEW JERSEY

You don't have to "law" with the Storey Company



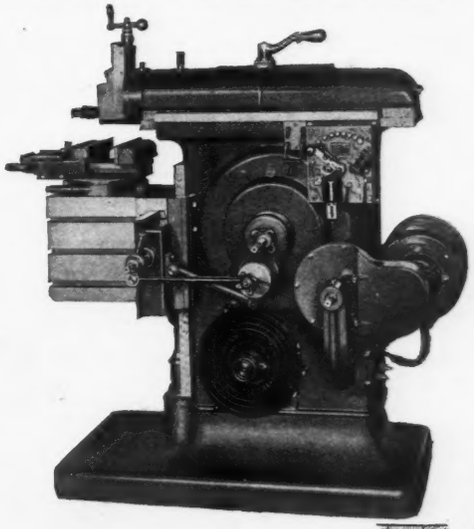
THE STOREY GUARANTEE IS AS GOOD AS A BOND

THOMAS J. FAY GEN'L MGR.

MULTI-VOLTAGE SYSTEMS ARE GOOD BECAUSE THEY WILL EAT UP YOUR SURPLUS CASH, AND SAVE YOU THE TROUBLE OF COUNTING IT. THERE ARE OTHER REASONS BESIDES. . . . . .

AGENCIES IN ALL PRINCIPAL CITIES

A motor that is inefficient is a thief.



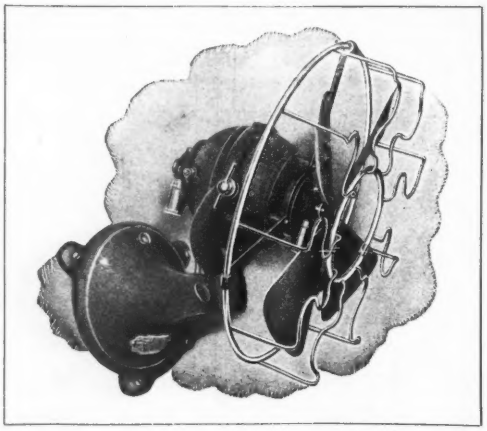
STOREY MOTORS HAVE BEEN TRIED AND FOUND HONEST

An INCANDESCENT LAMP represents a large investment of capital, ingenuity and skilled workmanship, it is sold at a price so low as to necessitate eternal vigilance in cutting costs to a minimum. A successful lamp manufacturer can not afford to experiment with poor materials. This explains the popularity of

BAKER & CO.'S PLATINUM

408 N. J. R. R. Ave., NEWARK, N. J. 120 LIBERTY ST., NEW YORK

We buy and Refine Platinum Scrap also



LUNDELL FANS

are acknowledged to be the best. They were the first efficient fans put on the market and still maintain their supremacy. They give the most satisfaction to dealer and user. Write for Catalogue 3046. :: :: :: :: :: :: :: :: :: ::

SPRAGUE ELECTRIC COMPANY

General Offices, 527-531 West 34th St., NEW YORK

Sterling Extra Insulating Varnish

STERLING EXTRA BLACK FINISHING VARNISH
STERLING BLACK AIR DRYING VARNISH
STERLING BLACK CORE PLATE VARNISH

The Sterling Varnish Co.
PITTSBURGH, PA., U. S. A.

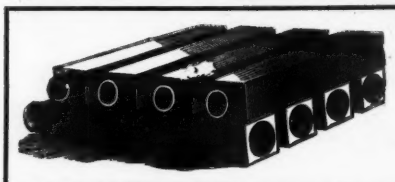
The Sterling Varnish Co.
BRAUGHTON ST., BLACKFRIARS ROAD, SALFORD, MANCHESTER, ENGLAND

LINO-TAPE

Not a rubber friction tape but a tape coated with linseed oil left slightly tacky. Ninety times the electrical restivity of Friction Tape. Send for samples and prices.

MICA INSULATOR CO. ORIGINATORS
218 Water St., NEW YORK 117 Lake St., CHICAGO

3



THE WYCKOFF PIPE & CREOSOTING CO. : : :

Portsmouth, Va.

MANUFACTURERS OF
Wyckoff Wooden Conduits,
CROSS-ARMS AND LUMBER.

EDISON MINIATURE LAMPS

are made in more than 10,000 VARIETIES

for all classes of work in Candelabra and Decorative Lighting, Multiple and Series Burning and in all types of Battery Lamps.

Miniature Sockets and Receptacles.

EDISON DECORATIVE & MINIATURE LAMP DEPT.

General Electric Co.,
Harrison, N. J.

7

Kilfyre DRY POWDER COMPOUND

IDEAL FIRE PROTECTION FOR ALL ELECTRICAL APPARATUS

Highest Awards at National Export, Central Canadian, Pan-American and Charleston Expositions.

MONARCH FIRE APPLIANCE COMPANY
247-249 Pearl St., NEW YORK CITY

WHEN ADDRESSING ADVERTISERS PLEASE MENTION THIS PAPER.

How did you learn the addresses on this page? Tell the advertiser WHEN YOU WRITE to him. :: :: ::

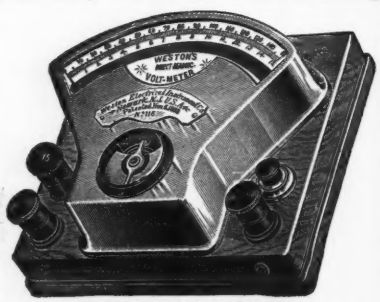
AMERICAN STORAGE CELLS ARE THE BEST

SEND FOR DESCRIPTIVE CIRCULAR
AMERICAN BATTERY CO.
173 S. CLINTON ST., CHICAGO, ILL.
ESTABLISHED 1899

WESTON Standard, Portable, Direct-Reading

Voltmeters, Ammeters
Millivoltmeters, Voltameters
Milliammeters, Ohmmeters
Portable Galvanometers
Ground Detectors and
Circuit Testers

Our Portable Instruments are recognized as THE STANDARD the world over. Our STATION VOLTMETERS AND AMMETERS are unsurpassed in point of extreme accuracy and lowest consumption of energy.



WESTON STANDARD VOLTMETER.

WESTON ELECTRICAL INSTRUMENT CO.

WAVERLY PARK, NEWARK, N. J.

BERLIN—European Weston Electrical Instrument Co., Ritterstrasse No. 88.
LONDON—Elliott Bros., No. 101 St. Martins Lane.

1

SPC Armature and Field Coil Varnish

PEACOCK BRAND SPC TRADE MARK REGISTERED

"STANDARD" for 15 Years

Absolutely water and acid-proof. Resists great heat. Does not chip or peel. We refer to every corporation which has used it.

The STANDARD PAINT COMPANY
Address Dep't E 100 William St., N. Y.

List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED FEBRUARY 3, 1903.

719,418 Electro-accumulator plate; A. Bainville, Nanterre, France.

719,432 Telephonic apparatus; C. G. Burke, Brooklyn, N. Y.

719,452 Trolley system for electric railways; J. S. Fox, Jackson, Mich.

719,458 Combined telegraph and telephone system; C. H. Gaunt, St. Paul, Minn.

719,468 Electric system for elevator safety appliances; G. Hail, Providence, R. I.

719,465 Electric clock; V. Himmer, Bayonne, N. J.

719,466 Traction apparatus; N. Hiss, New York, N. Y.

719,484 Apparatus for electrothermally treating materials; Hudson Maxim, London, England.

719,506 Electric lamp; H. N. Potter, New Rochelle, N. Y.

719,507 Electric furnace; H. N. Potter, New Rochelle, N. Y.—A tube composed of a mixture of dry electrolytes, and provided with confronting electro-circuit terminals arranged in pairs at its opposite ends, each member of each pair of terminals being in series with a separate ballast device.

719,508 Clamp device for electric welding machine; A. F. Rietzel, Lynn, Mass.

719,549 Liquid-resistance switch for electrical purposes; J. H. Woolliscroft, Sandycroft, England.

719,551 Electric time-alarm system; E. T. Ackerman, Chicago, Ill.

719,556 Telegraph instrument; E. Bing, Pernambuco, Brazil.

(Continued on page 60.)

THIS LABEL ON PACKING
PATENTED
"EUREKA"
TRADE MARK.
IS A GUARANTEE OF EXCELLENCE
Have you an INDICATOR?
Do you need a SEPARATOR?
Jas. L. Robertson & Sons, N.Y.

HYLO
The only artistic turn-down lamp.
The only economical turn-down lamp.
THE PHELPS CO.
29 Rowland St. - Detroit, Mich.

The FRANKLIN Model Shop
The Franklin Gas Engine
One-Half Horse-Power
Worth $100 complete. We sell all necessary castings, materials and detail drawings for $16.50. For real work—not a toy. 450 revolutions per minute. Upright or horizontal form. Finished parts sold separately. Runs by gas or gasolene. For boys and men with a mechanical turn. Write for circular 2. PARSELL & WEED
129-131 West 31st St., New York

ELECTRICAL TESTING
We are now prepared to undertake Electrical Testing of all kinds. Electrical and Photometrical Standardizations, Tests of Lamps, Instruments, Materials and Supplies. Secondary Standards of Candle-Power furnished. LAMP TESTING BUREAU, 14 Jay St., New York. Tel. 3388 Franklin.

ALPHADUCT MFG. CO.
522-524 W. 22D STREET
NEW YORK

TRANSFORMERS
For light and power service. Any voltage. Any size.

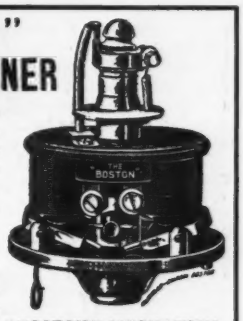
A special transformer for multiple arc street service.
Alternating current enclosed arcs, operated in multiple, is the most satisfactory street system in use to-day.
VINDEX ELECTRIC CO.
Factory, Aurora, Ill. CHICAGO, ILL.

SAMSON SPOT CORD

ARC LIGHT & TROLLEY CORD
Send for Samples SAMSON CORDAGE WORKS BOSTON MASS.

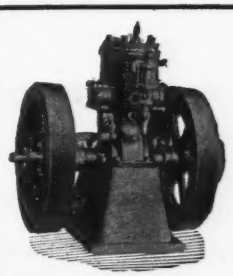
NOW IS THE TIME
TO SUBSCRIBE FOR
The Inventive Age & Patent Index
ONE DOLLAR A YEAR
Replete with matter pertaining to Patent Office and New Inventions
Contains index of all patents issued
ADDRESS
INVENTIVE AGE PUBLISHING CO.
918 F St., Washington, D. C.

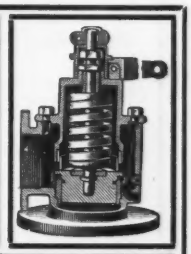
$3 VOLT AMMETER FOR STUDENTS' USE.
(Jewell Bearing and Aluminum Case.) Adapted to primary and storage battery work. List of schools using it mailed on application. The method of its use described in a circular just issued.
L. E. KNOTT APPARATUS CO.,
16 Ashburton Place, - - BOSTON, MASS.

THE "BOSTON" AUTOMATIC BURNER
The favorite of all first-class Electricians and is acknowledged by all to be the only reliable automatic in the market. Guaranteed perfect in every detail.
MANUFACTURED BY
Boston Electric Co.
29 Harrison Ave. Extension
BOSTON

"BOSTON" AUTOMATIC. "BOSTON" MECHANISM.

It's Perfect!
THE ALLEN
Soldering Stick (Flux) did it
Makes Solder Flow on any Metal
Large ALLEN Soldering S ick FREE for Trial
L. B. ALLEN CO., Incorporated, 1335 Columbia Avenue, Chicago (2)

CASE BROTHERS
MANUFACTURERS OF
INSULATING AND FULLER BOARDS
All Grades and Thicknesses
Heavy Special Boards to Order
Orders promptly filled from large stock on hand
Correspondence solicited
Highland Park, Conn.


GASOLENE ENGINES
FOR ISOLATED LIGHTING AND POWER PLANTS
STATIONARY, MARINE and AUTOMOBILE MOTORS
Send for Circular
THE LOWELL MODEL CO.
Drawer 1213 LOWELL, MASS.

The Consolidated Pop Safety Valve
is Nickel-Seated and can not Corrode or Stick. . . . . .
WRITE FOR OUR CATALOGUE

The Consolidated Safety Valve Co.
85-87-89 Liberty Street, ... New York 2

"Very Convenient"
The Chief Electrician of the Union Iron Works, San Francisco, writes:—"*I have had occasion to use the Leeds Testing Set several times and find it very convenient for rapid work.*"
This is the usual experience. If you want to measure resistances *quickly* use the *Leeds Portable Testing Set.* Ask for Catalogue.
JAMES G. BIDDLE
Stephen Girard Bldg. Philadelphia

PATENTS.

(Continued from page 59.)

719,566 Electric brake; F. E. Case, Schenectady, N. Y.—An electric brake, a mechanical brake, a common handle for actuating them and means for releasing the electric brake irrespective of the position of said handle.

719,600 Insulating high-potential apparatus; W. S. Moody, Schenectady, N. Y.

719,609 Power-factor indicator; W. H. Pratt, Lynn, Mass.—In a measuring instrument, the combination of unconnected and independently movable members adapted to measure quantities, each different from the other, and means for combining the indications of the members so as to produce a single resulting indication.

719,659 Galvanic battery; H. Halsey, New York, N. Y.

719,660-661 Electric battery; H. Halsey, New York, N. Y.

719,736 Service-meter system and apparatus for telephone exchanges; A. M. Bullard, Somerville, Mass.

719,752 Voltaic cell; M. E. Conrad, Atlantic, Iowa.

719,753 System of electrical distribution; New York, N. Y.—In a pole-changer, a movable member yieldingly maintained in one operative position, a counteracting electromagnet, and means for operatively energizing said

(Continued on page 63.)

Free Belting Test

"Royal Worcester" old-fashioned oak tanned belts known as the best—initial cost highest—operative cost lowest. Greatest belt power transmitters the world has ever known—50 years' reputation back of them.

Let us send you a sample belt to test, and to be returned free of expense to you if not entirely satisfactory.

GRATON & KNIGHT MFG. CO.
Oak Leather Belt Makers, Worcester, Mass.
(1)

For Sale—RAILS—Wanted for Cash.
NEW AND RELAYERS:
12 TO 56, ALSO 60 TO 80 Lbs.
PROMPT SHIPMENT.
Cars, Motors, Generators, Engines.
Write for JOHNSON'S EQUIPMENT BULLETIN.
Charles F. Johnson, 908 Ellicott Square, Buffalo, N. Y.

ELECTRIC CONDENSERS
WM. MARSHALL, Manufacturer
Standards a Specialty
709 Lexington Ave., New York

THE LAST REVISED EDITION

A DICTIONARY Of Electrical Words Terms and Phrases

By EDWIN J. HOUSTON, A.M., Ph.D. (Princeton), Emeritus Professor of Natural Philosophy and Physical Geography in the Central High School of Philadelphia; Professor of Physics in the Franklin Institute of Pennsylvania; Electrician of the International Electrical Exhibition, etc., etc.

Fourth Edition. Greatly Enlarged, with Over 6,000 Additional Words and Definitions Over the Third Edition. **Two Volumes,** 500 Pages Each. Bound in **Half-Leather.**

The regular price of this work is **$12.00,** but we will be pleased to supply a limited number of copies at **$6.00** per set of two volumes, expressage prepaid.

Electrical Review Pub. Co.

P. O. Box 339 13-21 Park Row, NEW YORK

DIRECT-CONNECTED RAILWAY UNITS

1—850-KW., Type M. P., 12-850-80, General Electric Generator, direct-connected to a 30 and 48x48 Cross-Compound, Penn. Iron Works, Corliss Engine. Speed, 80 R. P. M.

1—600-KW., Westinghouse, M. P. Generator, direct-connected to a 18 and 38x42, Cross-Compound, Corliss Engine, made by St. Louis Fdy. & Mach. Co. Speed, 100 R. P. M. BRAND NEW.

1—500-KW., Type M. P., 10-525-90, General Electric Generator, direct-connected to a 22 and 42x42 Tandem-Compound, Corliss. Speed, 90 R. P. M. BRAND NEW.

1—200-KW., Siemens & Halske, M. P. Generator, direct-connected to a 20x20 High-Speed Auto Engine, made by Columbus Iron Works.

1—500-KW., General Electric, with 28x60 Allis, 1890-Frame, Corliss Engine, with Countershaft. Operated by rope drive.

RAILWAY MOTORS

200—38-B., Westinghouse, 50-H. P. capacity.
150—12-A., Westinghouse, 30-H. P. capacity.
50—No. 68 Westinghouse.
25—No. 69 Westinghouse.
Lot of K., K.-2, K.-10, K.-11, K.-12 Controllers.

Rossiter, MacGovern & Co., Inc.

Factories
Jersey City, N. J.
St. Louis, Mo.

Main Office—141 BROADWAY, NEW YORK CITY

Branch Offices
Boston—St. Louis

APPARATUS

For POWER-HOUSE, CENTRAL STATION and FACTORY EQUIPMENT

Street-Railway, Direct-Connected Units

One 300-Kw. General Electric Generator, Class 8-300-100, 500-550 Volts, with G. E. Railway Panel, directly connected to one 18-30x48 Wetherill, Tandem-Compound, Corliss Engine, with Feed Water Heater and Condenser Unit, now Running. Inspection Invited. Early Delivery.

Alternators

One 250-kw., General Electric, 2400 volts, 50 cycles, three-phase.

One 200-kw., Stanley, 2200 volts, 60 cycles, two-phase.

Two 180-kw., General Electric, 1100 or 2200 volts, 60 cycles, single-phase.

One 150-kw., Stanley, 1100 or 2300 volts, 133 cycles, two-phase.

Two 120-kw., General Electric, 2080 volts, 125 cycles, single-phase.

One 120-kw., General Electric, 1040 volts, 125 cycles, single-phase.

One 60-kw., General Electric, 1100 volts, 125 cycles, single-phase.

Two 35-kw., Thomson-Houston, 1100 volts, 125 cycles, single-phase.

Street-Railway Generators

Two 500-kw., General Electric, class 6-500-300.

Two 225-kw., General Electric, class 6-225-465.

Two 200-kw., Westinghouse, 6-pole, speed 510 r. p. m.

One 200-kw., General Electric, class 4-200-425.

One 180-kw., Westinghouse, 4-pole, speed 535 r. p. m.

One 110-kw., Eddy, 4-pole, speed 600 r. p. m.

Two 100-kw., General Electric, class 4-100-650.

One 90 kw., Thomson-Houston, 4-pole, speed 700 r. p. m.

One 80-kw., General Electric, class 4-80-700.

Five D 62-kw., Thomson-Houston, speed 900 r. p. m.

Engines

Two 26x48, Providence, Greene.
One 200-kw., Westinghouse Generator, eight-pole, directly-connected to one 18-30x16 Westinghouse compound engine. Both engine and generator in excellent condition.
One 20x48, Harris-Corliss, with condenser.
One 20x36, Hewes & Phillips, with condenser.
One 18x42, improved, Greene.
Two 18-30x16, Westinghouse compound.
Two 13-23x17, McIntosh, Seymour & Co., tandem-compound.
One 18x48, Geo. H. Corliss.
One 16x42, Providence, Greene.
Two 10-18x20, Payne, tandem-compound.
One 12-30x12, Westinghouse, compound.
One 10½-16½x12, Armington & Sims, cross-compound.
Three 18½x18, Armington & Sims.
One 18½x18, New York Safety.
One 13x12, Armington & Sims.
One 14x14, Rice, automatic.
One 7x8, Payne.
Two 9x9, Taylor-Beck.

ALSO A LARGE STOCK OF DIRECT-CURRENT GENERATORS AND MOTORS, 110-220 AND 500 VOLTS

Direct-Connected Lighting and Power Units

One 187½-kw., Westinghouse, 8-pole, 120-volt generator, with 18-30x16, Westinghouse, compound engine.
One 60-kw., Eddy, 4-pole, 125-volt generator, Type G, with 13x12, Buffalo, forge engine; brand new.
One 50-kw., Commercial M. P., 125-volt generator, with 8½-13x12, Armington & Sims, tandem-compound engine.
One 50-kw., Eddy, 4-pole, 125-volt generator, Type G, with 13x13, Harrisburg, ideal engine.
One 35-kw., General Electric, 120-volt generator, 4-pole, with 9½x10, Armington & Sims engine.
Two 25-kw., Westinghouse, 6-pole, 250-volt generators, each with 9x10, Ball & Wood engine.
Two 25-kw., General Electric, 4-pole, 125-volt generators, with one triple-expansion, marine, vertical engine.

Arc Lamps

General Electric, Form 2, alternating, multiple enclosed.

General Electric, Form 2, direct current, multiple enclosed.

General Electric, Gilbert, Form 3, direct current, series enclosed, 6.6 amperes.

Victor, direct current, multiple enclosed, new.

Brush, No. 31, direct current, series, double carbon, 9.6 amperes, latest type.

Thomson-Houston, M2, M12, K2 and K12, direct current, series.

Arc Generators

Brush, No. 12, 9.6 amperes, 125 lights capacity.

Brush, No. 12, 6.6 amperes, 170 lights capacity.

Brush, No. 11, 9.6 amperes, 120 lights capacity.

Brush, No. 9½, 6.6 amperes, 120 lights capacity.

Brush, No. 9B, 6.6 amperes, 120 lights capacity.

Brush, No. 9, 9.6 amperes, 80 lights capacity.

Thomson-Houston, MD2, MD12, M12 and LD12.

Transformers

General Electric, Type H, 60 or 125 cycles, 1040 and 2080 primary, 52, 104, 208, 115 and 230 secondary. These are a recent type and efficient. All in good condition.

Thomson-Houston, Type F, 125 cycles, 1040 primary, 52, 104, 208 secondary.

Wagner, Types G and D, 60 cycles, 1040 and 2080 primary, 115 and 230 secondary.

Stanley, Types G and C, 60 cycles, 1000, 2000, 1040 and 2080 primary, 100, 115 and 230 secondary.

SEVEN 163 HORSE-POWER BABCOCK AND WILCOX BOILERS—120 LBS. PRESSURE, AND TUBULAR BOILERS OF ALL SIZES

SEND FOR OUR LATEST BULLETIN. Will make you a cash proposition for any apparatus you may have for disposal.

Charles E. Dustin Co.

Factory and Storehouse **Orangeburgh, N. Y.** **11 Broadway, New York**

PATENTS.

(*Continued from page 60*)

magnet by current in one direction only.

719,768 Electrohydraulic valve; C. Engberg, St. Joseph, Mich.

719,778 Storage-battery tank; B. Ford, Philadelphia, Pa.

719,791 Electrolytic cell; R. Grisson, Hamburg, Germany.

719,824 Electric brush-holder; H. T. Maker, Milwaukee, Wis.—A brush-holder comprising a cast-metal hub and a sheet-metal brush-supporting arm formed at one end with a sleeve for the brush and embedded at the opposite end in said hub.

719,859 Electrical contact for cartridge fuses; C. D. Platt, Bridgeport, Ct.

719,870–873 Electrolytic apparatus; C. J. Reed, Philadelphia, Pa.

719,901 Photochemical and electrotherapeutical apparatus; A. E. Sterne, Indianapolis, Ind.

719,915 X-ray apparatus for treating diseases; H. E. Waite, New York.

719,932 Danger signal for railways; C. P. Bass, Portland, Ore.

719,937 Storage battery; B. Ford, Philadelphia, Pa.

719,971 Magneto-electric generator mechanism; L. G. Wooley, Kenton, Ohio.

719,972 Telephone transmitter; J. A. Wotton, Atlanta, Ga.

719,973 Process of manufacturing electric condensers; J. A. Wotton, Atlanta, Ga.

REISSUE.

12,079 Electrical switch-operating mechanism; C. B. Russell, Marlboro, Mass.

WANTED

SALESMEN FOR INCANDESCENT LAMPS.

State age, height and weight, whether married or not, electrical experience, whether college graduate, what degree, and territory familiar with. Address

"INCANDESCENT"

Care ELECTRICAL REVIEW New York

SALESMEN WANTED

An Established Manufacturing Company in the Electric Railway Supply line requires several additional salesmen. State age, previous experience, salary required, etc. Must be thoroughly competent to handle first-class trade. Address "RAILWAY," Care ELECTRICAL REVIEW, NEW YORK.

Sales Agents WANTED

Several men wanted of first-class ability, persistent industry, experience and intimate acquaintance with managers and chief officials of Electric Light and Power Companies throughout the United States to sell electrical articles widely known and acknowledged as of the highest class and needed in quantities.

Technical electrical knowledge helpful and preferable but not strictly necessary. Applications will be held entirely confidential, but to enable advertisers to consider them understandingly, they must be complete and explicit with all requisite information including previous experience and expectations. No others will receive any attention. Excellent opportunity for right men. Address

FENSTO,

Care ELECTRICAL REVIEW, New York

DEALERS WRITE FOR DISCOUNT

LINEMEN SEND $1.50 FOR A PAIR OF MY 3 RIVETS CLIMBERS

J. DONNELLY PATENT PENDING

U CAN RE-SPUR THESE. I WILL MAIL 2 SPURS POST PAID FOR 40 CTS.

SOLE MAKER JOHN DONNELLY

BOX 379, BRANFORD, CONN. U.S.A.

WANTED — Working Superintendent

for Electrical Repair Works employing from 10 to 20 men.

Must be capable of handling all types of armatures, fields, commutators, etc., and familiar with lathes and shop tools. State age, experience and salary expected and address in own handwriting.

The Sackett Mine Supply Co., Columbus, O.

WANTED

A reliable Armature Winder familiar with all kinds of bipolar and multipolar windings. Address

F. A. CULBERT

COLD SPRING, PUTNAM CO., N. Y.

HAWES & GRAY

ENGINEERS AND CONTRACTORS

High-Tension Work a Specialty

Steam, Hot-Water and Warm-Air Heating

137 State St Springfield, Mass.

THE BRADY MAST ARMS

T. H. BRADY, New Britain, Conn., U. S. A.

MANUFACTURER OF

Mast Arms, Pole and Swinging Hoods, House Brackets and other specialties for construction work

Catalogue and Prices Furnished on Application

Two Volts Each Cell Low Internal Resistance

PULLEN CELLS

Will operate everything Electrical

Leon W. Pullen Elec. Co.

16 Chestnut St., Philadelphia, Pa.

Its Come Out! What Has? Its Come Out! Why the

MODEL ELECTRICAL AND MECHANICAL ENGINEER

The best journal published for amateurs and students.

Single Copies, 10c. One Year, $1.00

ROBERT THISTLEWHITE, Publisher

Box 625 Dover, New Jersey

Chicago Fuse Wire and Mfg. Co.

Manufacturers

FUSE WIRE

FUSE LINKS

TELEPHONE FUSES

and SUPPLIES

ANNOUNCEMENT

Owing to the steady growth of our business and to enable us to supply our Eastern customers more promptly, we have equipped a complete factory for the manufacture of our goods at 187 Pratt Street, Buffalo, N. Y. We are now manufacturing and shipping at this address under the supervision of competent and experienced men who are thoroughly trained in the details of the business.

New York Office, 853 Broadway

Main Office, 358 Dearborn St., Chicago

Agent for United States and Foreign PATENTS.

ESTABLISHED 1880.

GEO. H. BENJAMIN, M. E., Ph. D.

45 BROADWAY, N. Y.

Specialty: The preparation of specifications for patents requiring an expert knowledge of the arts and sciences. Searches.

Highest References.

ATLANTIC INSULATED WIRE AND CABLE CO.

WIRES AND CABLES

FOR SUBMARINE, AERIAL, UNDERGROUND AND INTERIOR USE

FACTORY STAMFORD, CONN.

120 LIBERTY STREET NEW YORK CITY

OPENING WANTED

Man twenty-two has had eight months' factory experience with General Electric Company—intelligent, ambitious, fair business training—wants opening in commercial or electrical business. Will show good references and endorsements. "R. G. T." care

ELECTRICAL REVIEW • NEW YORK

ELECTRICAL ENGINEERING TAUGHT BY MAIL

Write for our free illustrated book "CAN I BECOME AN ELECTRICAL ENGINEER?"

We teach Electrical Engineering Electric Lighting, Electric Railways, etc., at your home by mail. Institute indorsed by Thos. A. Edison.

ELECTRICAL ENGINEER INSTITUTE

Dept. M, 240-242 West 23d St., New York.

E. S. DUVALL

GET MY CHARGES

PATENTS

QUICK SERVICE

PATENTS

LOW FEES

E. S. DUVALL

LOAN & TRUST BLDG.

WASHINGTON, D. C.

PATENTS

Caveats, Trade-Marks, Copyrights and Designs.

Send your business direct to Washington.

Saves time and insures better service.

PERSONAL ATTENTION

GUARANTEED.

22 YEARS' ACTIVE PRACTICE.

Specialty—

PATENTS THAT PROTECT

Address—

SIGGERS & SIGGERS

PATENT LAWYERS.

Suite 20-25

National Union Bldg. Washington, D. C.

COAL AND ASHES

HANDLING MACHINERY

We have manufactured this kind of machinery for thirty years.

C. W. HUNT COMPANY

WEST NEW BRIGHTON, N. Y.

See our adv. opposite page next week.

McINTIRE'S PATENT

Connectors and Terminals.

Special Connectors for HARD-DRAWN COPPER WIRE, all sizes. FUSED WIRE, FUSED LINKS and STRIPS.

THE C. McINTIRE CO.,

13 & 15 Franklin St., Newark, N. J.

COLUMBIA ARC LAMPS

ECONOMICAL

SIMPLE, DURABLE

COLUMBIA ELECTRIC & MFG. CO.

Office & Factory, 316-322 Market St.

NEWARK, N. J.

THE SCHWERDTLE STAMP CO.,

STENCILS-BURNING BRANDS-STEEL STAMPS & DIES-SEALS-MACH. PLATES-CHECKS

BRIDGEPORT, CONN.

EUREKA

Coloring and Frosting Compounds are

PERFECTION

For Incandescent Electric Light Globes

Put up in any size package from 4 ounces to 5 gallons. Write for prices.

EUREKA ELECTRIC COLOR CO.

21 & 23 Ann Street New York

INDELIBA

Carbon Paper Will not Smut

INDELIBA

Typewriter Ribbons Are Non-Filling

INDELIBA

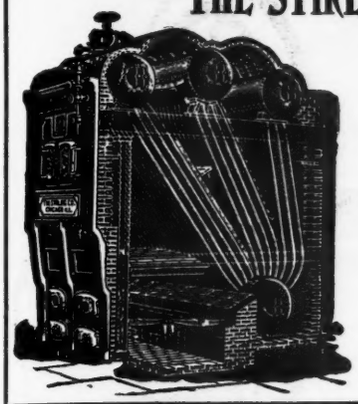
Goods Are the Best on the Market

SAMPLE AND CATALOGUE FOR THE ASKING

E. F. P. RAPPEL

5 & 7 Dey St. New York

THE STIRLING WATER-TUBE SAFETY BOILER.



Safe.
Efficient.
Durable.

Over 1,000,000 Horse-Power in use.

All wrought metal; no flat surfaces or stay bolts; four manholes give access to every tube. Quick and steady steam and thorough circulation guaranteed.

THE STIRLING COMPANY

Pullman Bldg., Chicago, Ill.
New York Office, 114-118 Liberty St.
Philadelphia Office, Betz Bldg.
Boston Office, Delta Bldg.

THE BABCOCK & WILCOX CO.

85 LIBERTY ST. NEW YORK
CABLE ADDRESS NEW YORK "GLOVEBOXES" ALL FOREIGN OFFICES "BABCOCK"

STEAM

WATER TUBE BOILERS

SEND FOR OUR BOOK "STEAM"

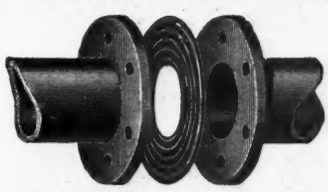
BRANCH OFFICES

BOSTON 85 FEDERAL ST.
PHILADELPHIA NORTH AMERICAN BLDG.
CHICAGO 1285 MARQUETTE BLDG.
NEW ORLEANS 315 CARONDELET ST.
PITTSBURGH
SAN FRANCISCO 32 FIRST ST.
CLEVELAND NEW ENGLAND BLDG.
ATLANTA, GA. 817 EQUITABLE BLDG.
MEXICO CITY, 7 AVENIDA JUAREZ
HAVANA, CUBA 61 CALLE DE LA HABANA

JEFFREY ELEVATING, CONVEYING, POWER TRANSMISSION MACHINERY

FOR CATALOGUE, ADDRESS THE JEFFREY MFG. CO. COLUMBUS, O.

Our... Patented **Mineral Wool Coverings and Copper Gaskets**



THEY SAVE STEAM AND MAKE ABSOLUTELY TIGHT JOINTS

U. S. MINERAL WOOL CO.
106 West St.
NEW YORK - - N. Y.

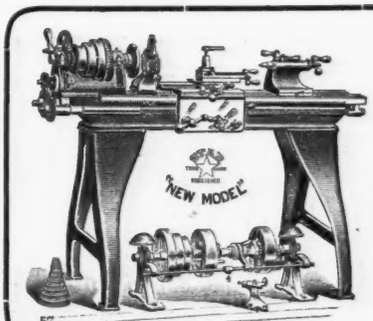
"The King's Highway."

TO THE GATEWAYS OF COMMERCE THROUGH THE CENTERS OF POPULATION

adding greatly to the interest of your journey, without increasing its expenses beyond what you would expect to pay for the "best," which you secure if you travel by the

NEW YORK CENTRAL LINES

A Copy of "Four-Track Series" No. 13. "Urban Population in 1900," will be sent free, on receipt of a two-cent stamp by George H. Daniels, General Passenger Agent, New York Central & Hudson River R. R., Grand Central Station, New York.



FOOT and POWER
"Star" Lathes
(9, 11, 13-Inch Swing)

Have forged crucible steel hollow spindles, phosphor bronze bearings, graduated cross feed screw, improved interchangeable plain and compound rests with graduated base, exclusive gear-driven reversible cross and longitudinal feeds. Can furnish U. S. Standard, Whitworth or Metric Lead Screws, Taper Attachment, Draw-in-Chuck and Collets, and Gear-Cutting and Milling Attachment.

Send for Catalogue "B"

The Seneca Falls Mfg. Co.
420 Water St.
SENECA FALLS, N. Y., U. S. A.

57

EXPOSITION FLYER

VIA

"BIG FOUR"

FROM

CINCINNATI

TO

ST. LOUIS

WRITE FOR RATES AND FOLDERS

WARREN J. LYNCH, Gen'l Pass. & Tkt. Agt.
W. P. DEPPE, Asst. Gen'l P. & T. A.
CINCINNATI, OHIO

McGILL UNIVERSITY MONTREAL CANADA

Courses in Architecture, Civil Engineering, Mechanical Engineering, Electrical Engineering, Mining Engineering, Practical Chemistry.

For descriptive pamphlet or information, address

J. A. NICHOLSON, Registrar
HENRY T. BOVEY, Dean

University of Wisconsin MADISON WIS.

College of Mechanics and Engineering

Courses in Civil, Sanitary, Mechanical, Electrical and Electro-Chemical Engineering. All professional instruction given by men of large practical experience in their respective departments. Completely equipped shops and laboratories. Graduate students received in all courses. Gymnasium, boating facilities and athletic opportunities unexcelled. Fees moderate. "Madison has the most magnificent site of any inland town of America." It is as healthful as it is beautiful. For catalogue or information, address

J. B. JOHNSON, Dean, Madison, Wis.

W. R. OSTRANDER & CO.
22 DEY STREET, NEW YORK,
MANUFACTURERS OF
Speaking Tubes, Whistles, Annunciators.
Electric and Mechanical Bells.

FACTORY: DeKALB AVE. BROOKLYN.

Send for Illustrated Catalogue.

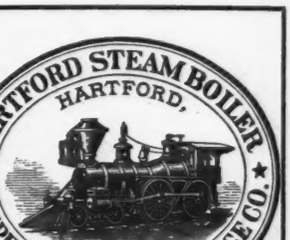
CALIFORNIA

For illustrated folder and full information via all lines including itinerary covering reverse route if desired, address W. H. Underwood, G. E. P. A. Michigan Central R. R., 299 Main Street, Buffalo, N. Y.

M. J. BLAKE MICHAEL BLAKE

M. J. & M. BLAKE
IRON AND STEEL SCRAP
79 TENTH AVENUE
COR. 15TH STREET
Telephone Connection 897 18th St. NEW YORK

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
HARTFORD, CONN.



ELECTRIC LAUNCHES

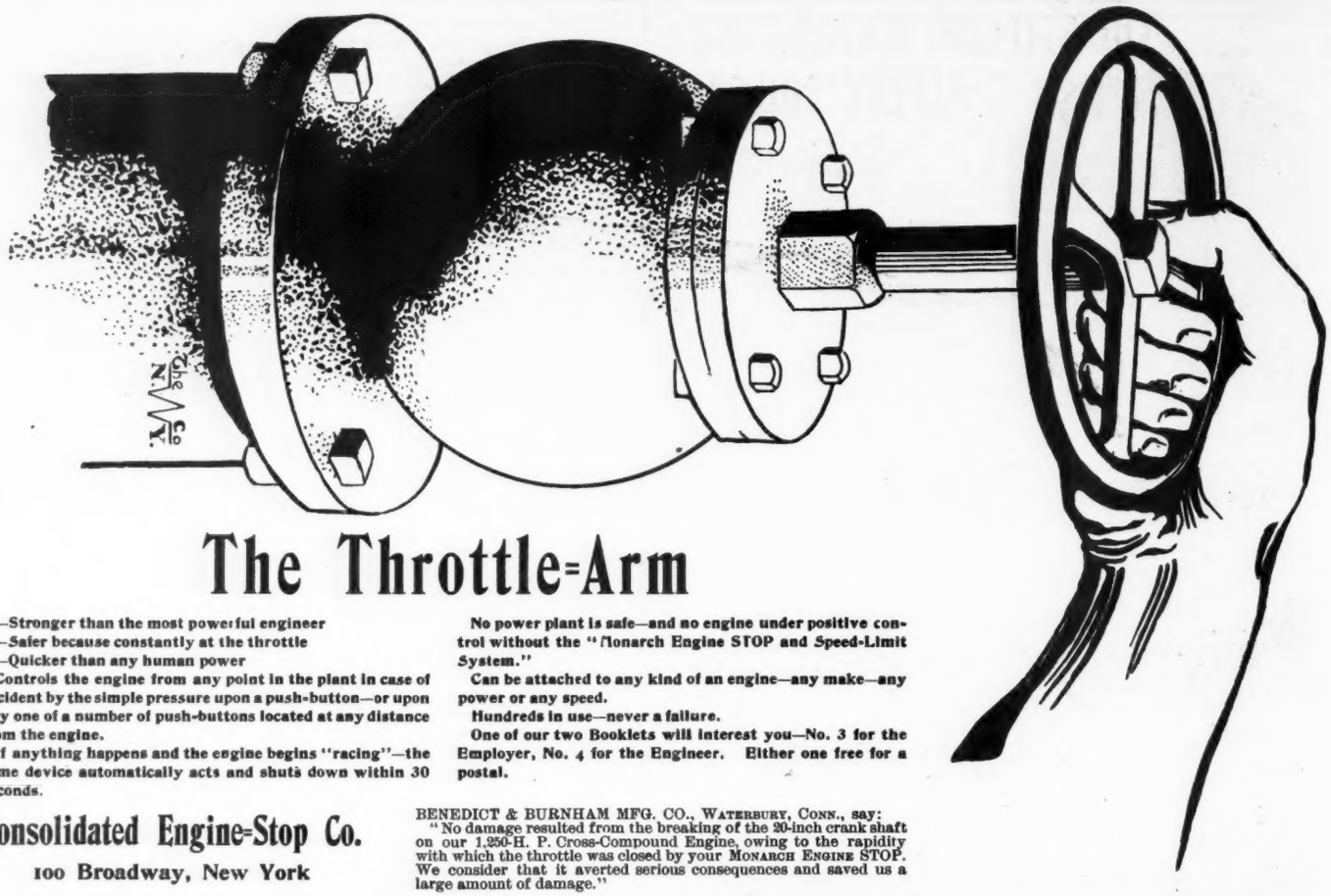
A PAYING INVESTMENT AT PARKS AND PLEASURE RESORTS

Can't Explode

SIMPLE IN CARE RELIABLE IN OPERATION

No Heat - No Smoke - No Smell

THE ELECTRIC LAUNCH COMPANY
Avenue A and North Street
BAYONNE CITY, N. J.



The Throttle-Arm

—Stronger than the most powerful engineer
—Safer because constantly at the throttle
—Quicker than any human power

Controls the engine from any point in the plant in case of accident by the simple pressure upon a push-button—or upon any one of a number of push-buttons located at any distance from the engine.

If anything happens and the engine begins "racing"—the same device automatically acts and shuts down within 30 seconds.

No power plant is safe—and no engine under positive control without the "Monarch Engine STOP and Speed-Limit System."

Can be attached to any kind of an engine—any make—any power or any speed.

Hundreds in use—never a failure.

One of our two Booklets will interest you—No. 3 for the Employer, No. 4 for the Engineer. Either one free for a postal.

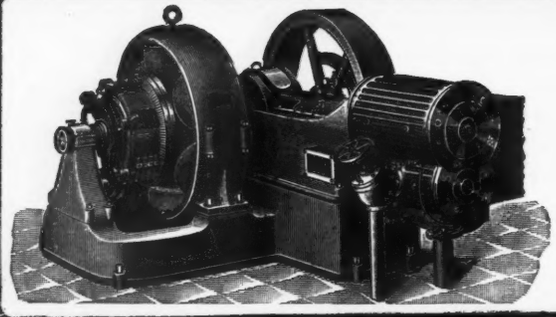
Consolidated Engine-Stop Co.

100 Broadway, New York

BENEDICT & BURNHAM MFG. CO., WATERBURY, CONN., say:
"No damage resulted from the breaking of the 20-inch crank shaft on our 1,250-H. P. Cross-Compound Engine, owing to the rapidity with which the throttle was closed by your MONARCH ENGINE STOP. We consider that it averted serious consequences and saved us a large amount of damage."

AMERICAN-BALL DUPLEX COMPOUND ENGINE AND DIRECT CONNECTED GENERATOR

The 20th CENTURY ENGINE SAVES 25%



A Simple Engine wastes 25% of your fuel. The DUPLEX COMPOUND requires no more room, no more attention and no greater cost of maintenance, and its small additional first cost is more than saved every year.

You can't afford to take a simple engine as a gift and pay the extra cost of fuel.

AMERICAN ENGINE COMPANY

NEW YORK OFFICE
No 95 LIBERTY ST.

No 48 RARITAN AVE., BOUND BROOK, N.J.

TRADE PAPER ADV. AGENCY, N.Y.

GARRIGUS MECHANICAL BOILER CLEANER

THE ONLY KNOWN METHOD OF KEEPING BOILERS CLEAN AND FREE OF SCALE.
INSTALLED OUR EXPENSE ON 60 DAYS TRIAL

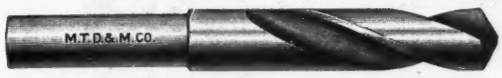
MECHANICAL BOILER CLEANER CO.

W. R. MASON MANAGER. 413 WESTERN UNION BUILDING. CHICAGO.

MORSE TWIST DRILL AND MACHINE CO.

New Bedford, Mass., U. S. A.

No. 112 DRILLS FITTING SILVER & DEMING'S AND PRENTICE BLACKSMITHS' DRILL PRESSES NOS. 1 AND 2, WITH SHANKS ½ INCH DIAMETER. SHORT LENGTHS.

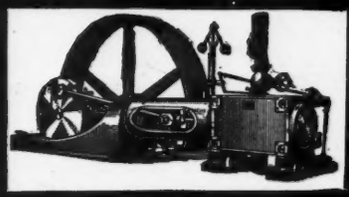


Drills larger than ¾ inch, with Shanks ½ inch diameter and Drills with Shanks .647 inch diameter, fitting Silver & Deming's Press Nos. 3 and 4, same price as No. 110 for Coe's Drill Press. All Drills 7/8 inch and larger are 6 inches entire length. Shanks for No. 112 Drills 2¼ inches long.

(1)

ALLIS-CHALMERS CO.,

GENERAL OFFICES CHICAGO, HOME INS. BLDG.



Reynolds Corliss Engines.

PUMPING, BLOWING AND HOISTING ENGINES.
RIEDLER PUMPS AND COMPRESSORS.
SPECIAL ENGINES FOR STREET RAILWAYS AND ELECTRIC LIGHTING.

Shelby Useful Light Lamps

50 to 100% More Light Where You Want It the Most

BRANCH OFFICES IN ALL LARGE CITIES

THE SHELBY ELECTRIC COMPANY

100 Seco St., Shelby, Ohio

The Ball & Wood High-Speed Engine

is noted for its smooth and silent running and its extremely low cost of maintenance. It is recognized as the standard engine for electric light and railway plants. BALL & WOOD engines are made in all types for all services requiring the best economy and efficiency

THE BALL & WOOD CO.

Works: ELIZABETHPORT. N. J.

120 Liberty St., New York City

OUTLINES OF ELECTROCHEMISTRY

By H. C. Jones, Associate Professor of Physical Chemistry in the Johns Hopkins University.

Cloth binding. 109 pages. Numerous Illustrations.

Price, postage prepaid, $1.50

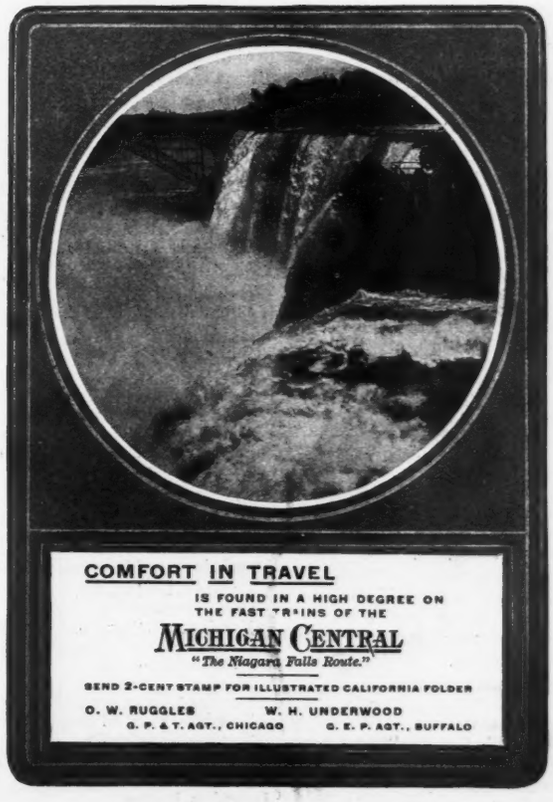
ELECTROCHEMISTRY is the new direction of advance in Electrical Engineering. Professor Jones has combined in these "Outlines" the essentials of the new theories of electrolytic action and built a bridge upon which any reader who knows the ordinary applications of Electrodynamics may cross into the interesting and fruitful region of Electrochemistry.

The work is of timely value, and its lucid style and logical arrangement make it of permanent worth to students, engineers and laymen.

THE

Electrical Review Publishing Company,

Park Row Building, New York.



COMFORT IN TRAVEL

IS FOUND IN A HIGH DEGREE ON THE FAST TRAINS OF THE

MICHIGAN CENTRAL

"The Niagara Falls Route."

SEND 2-CENT STAMP FOR ILLUSTRATED CALIFORNIA FOLDER

O. W. RUGGLES, G. P. & T. AGT., CHICAGO
W. H. UNDERWOOD, G. E. P. AGT., BUFFALO

The high price of coal is one of the best arguments necessary to demonstrate the value of our system of steam distribution. Through its installation, electric and other power companies are enabled to sell their exhaust steam for heating purposes for enough to pay all their station expenses and interest on the investment for their steam mains. We have installed over thirty-five of these exhaust steam-heating plants this year, and we can guarantee results.

If you wish to know how it is done, write for our pamphlet.

AMERICAN DISTRICT STEAM CO.

MENTION ELECTRICAL REVIEW LOCKPORT, NEW YORK

CLASSIFIED INDEX

(*Continued from page 48.*)

Engineers and Contractors.
Arnold Electric Power Station Co.
Barstow, W. S.
Kutsch, L. W.
Lyndon, Lamar.
McTighe, T. J.
New England Engineering Co.
Rae, Frank B.
Reuterdahl, Arvid.
Runyon, F. O.
Sheaff & Jaastad.
Vail, J. H.
White & Co., J. G.
Wilmerding, C. H.

Fans and Fan Motors.
Central Electric Co.
Diehl Mfg. Co.
Fort Wayne Electric Works.
General Electric Co.
Gen'l Incandescent Arc Light Co.
Hunter Fan & Motor Co.
Jandus Electric Co.
Pacific Electric Co.
Power Installation Co.
Robbins & Myers Co.
Sprague Electric Co.
Warren Electric & Specialty Co.
Westcott, Geo. F.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Fan Motor Appliances.
The Coleman Mfg. Co.

Feed Water Heaters.
Stilwell-Bierce & Smith-Vaile Co.

Fire Extinguisher.
Monarch Fire Appliance Co.

Flexible Shafting.
Stow Manufacturing Co.

Fuses.
D. & W. Fuse Co.
Johns-Manville Co., H. W
McIntire Co., The C.

Fuel Economizers.
Green Fuel Economizer Co.

Gaskets.
U. S. Mineral Wool Co.

Globes, Shades, Etc.
Frink, I. P.
Phœnix Glass Co.
Wheeler Reflector Co.

Graphite.
Dixon Crucible Co., Jos.

Heating Apparatus.
American Electric Heater Co.
Simplex Electrical Co.

House Goods.
Boston Electric Co.
Central Electric Co.
Ostrander & Co., W. R.

Hoisting Machinery.
Brown Hoisting Machinery Co.
Jeffrey Mfg. Co.

Incandescent Lamp Coloring.
Eureka Electric Color Co.

Injectors.
Hayden & Derby Mfg. Co.
Lunkenheimer Co., The

Instruments.
Biddle, Jas. G.
Bristol Co.
Bullock Electric Mfg Co.
Gen'l Incandescent Arc Light Co.
Jewell Electrical Instrument Co.
Keystone Electrical InstrumentCo.
Knott Apparatus Co., L. E.
Machado & Roller.
Pignolet, Louis M.
Stanley Instrument Co.
Wagner Electric Mfg. Co.

Insulators and Insulating Material.
Brookfield Glass Co.
Case Brothers.
Hemingray Glass Co.
Massachusetts Chemical Co.
Mica Insulator Co.
Standard Paint Co.
Standard Underground Cable Co.
Standard Vitrified Conduit Co.
Sterling Varnish Co.
Steward Mfg. Co., D. M.
Thomas & Sons Co., R.

Junction Boxes.
Bossert Electric Construction Co.
Gen'l Incandescent Arc Light Co.

Lamps, Arc.
Adams-Bagnall Electric Co.
Columbia Electric & Mfg. Co.
General Electric Co.

Lamps, Arc.
Gen'l Incandescent Arc Light Co.
Helios-Upton Co.
Jandus Electric Co.
Nernst Lamp Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Lamps, Decorative.
Central Electric Co.
Edison Deco. & Miniature Lamp Dep.
Gen'l Incandescent Arc Light Co.
Rooney & Westbury Elec. Lamp Co.
Sawyer-Man Electric Co.

Lamp Guards.
P. R. Wagor & Co.

Lamps, Incandescent.
Banner Electric Co.
Bryan-Marsh Co.
Buckeye Electric Co.
Columbia Incandescent Lamp Co.
Economical Electric Lamp Co.
Fort Wayne Electric Works.
General Electric Co.
Gen'l Incandescent Arc Light Co.
Lamp Testing Bureau.
Nernst Lamp Co.
New York & Ohio Co.
Phelps Co.
Sawyer-Man Electric Co.
Schlesinger & Mears.
Shelby Electric Co.
Standard Electric Mfg. Co.
Sterling Electrical Mfg. Co.
Warren Electric & Specialty Co.
Western Electric Co.

Lathes.
Seneca Falls Mfg. Co.

Launches.
Electric Launch Co.

Lighting Plants.
Bullock Electric Mfg. Co.
Christensen Engineering Co.
Crocker-Wheeler Co.
Fort Wayne Electric Works.
Reuterdahl Electric Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Lightning Arresters.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Lubricators.
Lunkenheimer Co., The
Siegrist Lubricator Co.

Machine Tools and Machinery.
Brown Hoisting Machinery Co.
Jeffrey Mfg. Co.
Morse Twist Drill & Machine Co.
New England Butt Co.

Mast Arms.
T. H. Brady.

Meters.
Duncan Electric Manufacturing Co.
Fort Wayne Electric Works.
Stanley Instrument Co.
Westinghouse Electric & Mfg. Co.

Mica.
Mica Insulator Co.
Munsell, Eugene.

Model Makers.
Franklin Model Shop.
Parsell & Weed.

Name-Plates.
The Schwerdtle Stamp Co.

Nippers and Pliers.
Smith & Hemenway Co.
Utica Drop Forge & Tool Co.

Paint.
Massachusetts Chemical Co.
Standard Paint Co.

Patent Solicitors.
Benjamin, Geo. H
Cullen, Orlan Clyde
Duvall, Edw. S.
Siggers & Siggers.

Pipe Covering.
U. S. Mineral Wool Co.

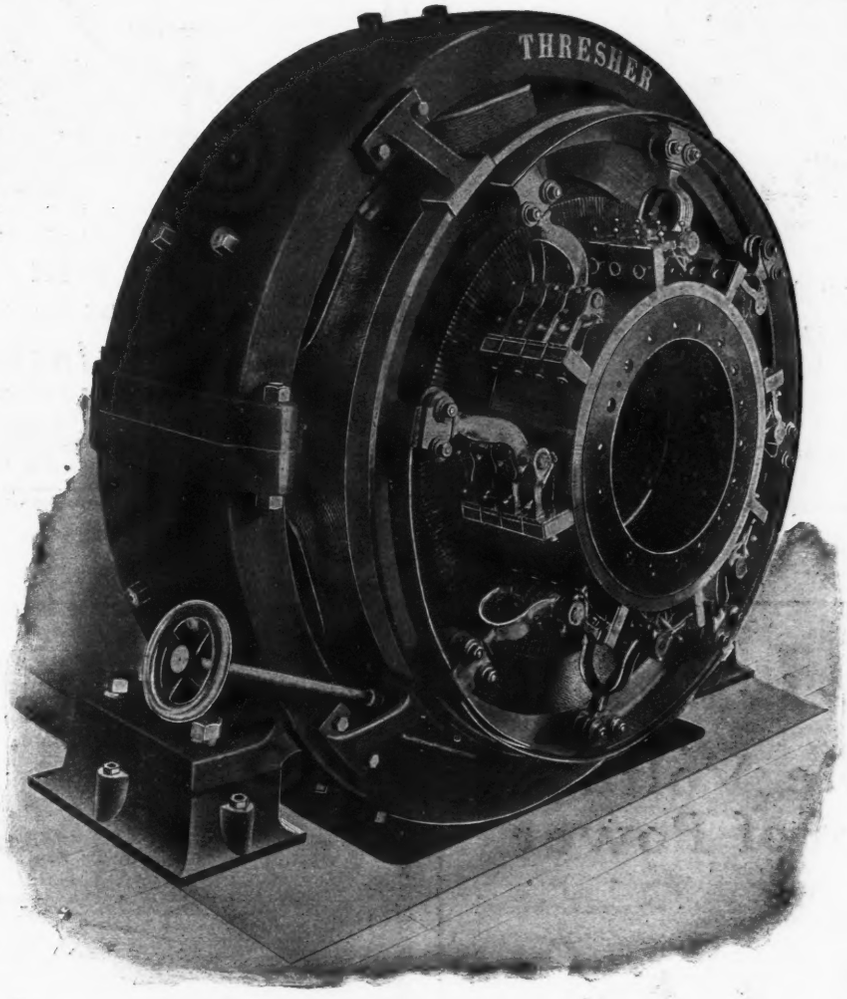
Platinum.
Baker & Co.

Poles, Brackets, Pins, Ties, Cross-Arms, Climbers, Etc.
Donnelly, John
Eccleston Lumber Co
Fowler, John H.
Klein & Sons, Mathias.
Lindsley Brothers Co.
Phelan, D. W.
Standard Pole & Tie Co.

(*Continued on page 70.*)

THRESHER

Engine Type Generators possess all the essential features of a perfect running machine



THRESHER MULTIPOLAR GENERATOR

Complete Equipments for Electric Railways, Lighting and Power Transmission

Manufactured by

THE THRESHER ELECTRIC CO.

MAIN OFFICE AND WORKS
Dayton, Ohio, U. S. A.

NEW YORK OFFICE
120 Liberty Street

Browning Motors and Dynamos

HIGH GRADE AND MODERN IN EVERY WAY

Motors, ... 1-8 to 15 H. P.
Dynamos, ... 1-2 to 12 1-2 K. W.

WRITE FOR BULLETIN

The Browning Manufacturing Co.

MILWAUKEE, U. S. A.

Eastern Representatives
D'OLIER ENGINEERING CO.
New York, Philadelphia, Baltimore

Southwestern Representatives
WESTERN ELECTRICAL SUPPLY CO.
St. Louis

Foreign Department: GOUDEY-McLEAN CO., 88 Maiden Lane, New York

THE RANGE OF THIS COMBINATION OF

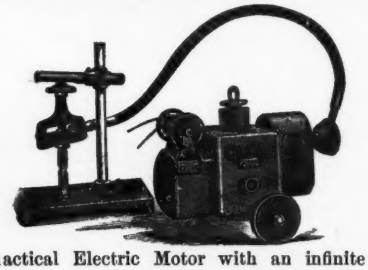
Flexible Shaft and Multi-Speed Motor

IS LIMITED ONLY BY THE LENGTH OF CONDUCTING WIRE ON THE REEL

For All-Around Portable Work it has no equal

DRILLING, TAPPING, REAMING, EMERY GRINDING

A Portable Machine Shop in Itself



The only practical Electric Motor with an infinite variety of speeds within extreme limits

SELF CONTAINED - - NO OUTSIDE STARTER OR RHEOSTAT

Shall We Mail You Catalogue?

Stow Manufacturing Co.

BINGHAMTON, N. Y.

General European Agents; SELIG, SONNENTHAL & CO., 85 Queen Victoria Street, LONDON, ENGLAND

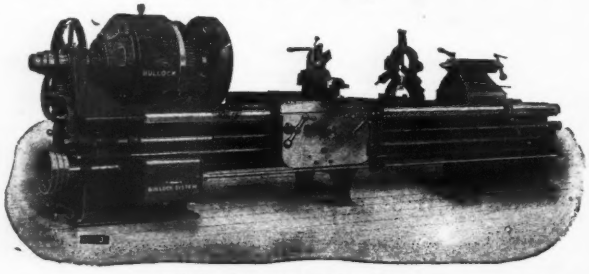
See Stationary Motors in Next Issue

BULLOCK

Multiple Voltage System of Power

(PATENTED)

It has been demonstrated that this system is the only successful method of operating machine tools by electric power.



TYPE "N" BULLOCK MOTOR
Direct-Connected to Schumacher & Boye 22-Inch Lathe

Some of the advantages of this system are: —
It gives the motor a constant torque, regardless of speed.
When motor is set to run at any one speed, it will run at this speed, regardless of the load.
The different speeds are obtained without passing the current through any external resistance.

Write for Bulletin 1009.

Bullock Electric Mfg. Co.

CINCINNATI, U. S. A.

(403)

JUST PUBLISHED

Electric Lighting

VOLUME II, BY F. B. CROCKER

A practical exposition of the art, for the use of electricians, students and others, by ***Francis B. Crocker, E. M., Ph.D.,*** Professor of Electrical Engineering, Columbia College, New York; Past-President of the American Institute of Electrical Engineers.

Volume II—Distributing System and Lamps. In this volume is taken up the subject of the distributing systems, including the calculations of both direct and alternating-current lines. This comprises overhead, underground and interior wiring. The electric arc is very fully treated, and the arc and incandescent lamps are given the prominent part that the name of the book would indicate.

CONTENTS. CHAPTER I — Physical Properties of Conductors. CHAP. II—Series System of Electrical Distribution. CHAP. III—Parallel Systems of Electrical Distribution. CHAP. IV—Three and Five-Wire Systems of Electrical Distribution. CHAP. V—Direct-Current Transformers Systems of Electrical Distribution. CHAP. VI—Networks of Electrical Conductors. CHAP. VII—Principles of Alternating Currents. CHAP. VIII—Principles of Alternating-Polyphase Currents. CHAP. IX — Transformers. CHAP. X — Alternating-Current Systems of Distribution. CHAP. XI — Calculation of Alternating-Current Lines. CHAP. XII — Overhead Conductors. CHAP. XIII—Underground Conductors. CHAP. XIV—The Electric Arc. CHAP. XV—The Arc Lamp. CHAP. XVI—Interior Wiring. CHAP. XVII — Meters. CHAP. XVIII — Incandescent Lamps. APPENDIX I—National Electric Code. Underwriters' Rules. APPENDIX II—Report of the Standardization Committee.

8vo, Cloth, about 425 Pages
Illustrated; Price $3.00

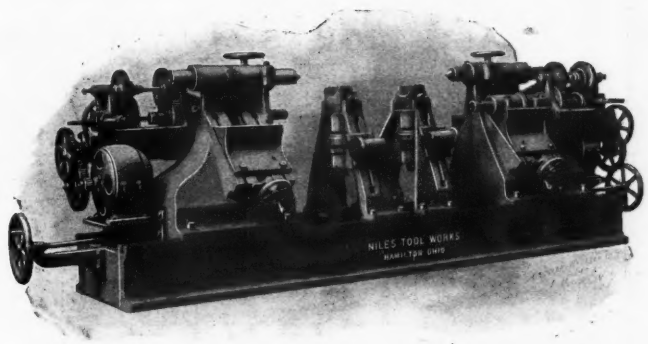
Electrical Review Publishing Co.

13 to 21 PARK ROW

Box 339 NEW YORK

Crocker-Wheeler Company

MANUFACTURERS AND ELECTRICAL ENGINEERS
OF AN EFFICIENT SYSTEM OF ELECTRIC DRIVE

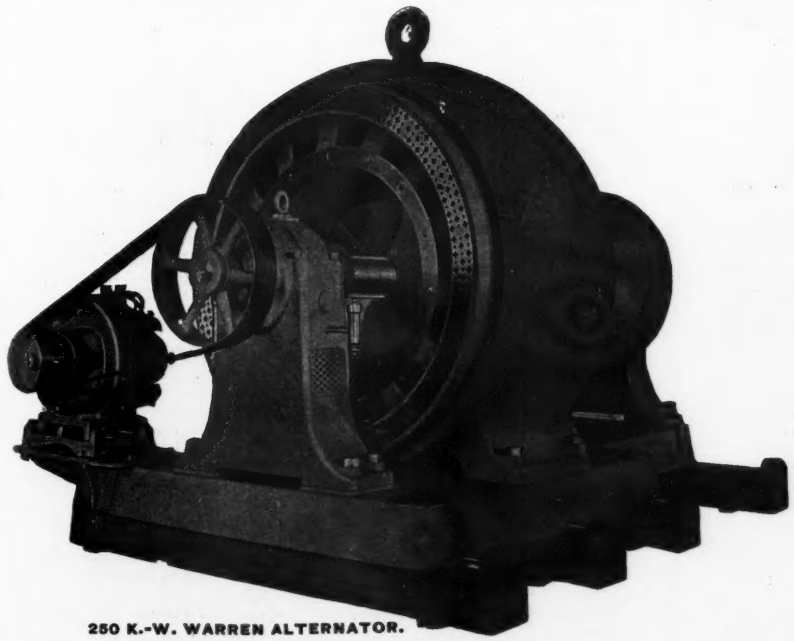


Motor-Driven Quartering Machine. L. S. & M. S. R. R. Shops, Collinwood, Ohio.

The C-W Motors with up-to-date methods of tool applications will give large increases in the output of your shop.

SALES OFFICES IN ALL LARGE CITIES

Office and Works ❧ ❧ **Ampere, N. J.**



250 K.-W. WARREN ALTERNATOR.

The
WARREN Alternator

of the past has possessed an inherent regulation far surpassing any other alternator known. By inherent regulation is meant the quality of maintaining a given voltage without the use of any extraneous device, such as compounding coils, which in all cases require compensating commutators with brushes, collector rings, etc. Remove these devices from any known alternator and the generator would be practically useless.

A recent discovery as to the actual relation of copper to iron as applied in an Inductor Alternator has led to a still further improvement, to the extent of securing an actual working regulation close to perfection, and this still without the necessity of compounding or other external devices.

ALL WARREN ALTERNATORS
of the future will embody this improvement

REGULATION WILL HENCEFORTH BE OUR CHALLENGE

WARREN ELECTRIC MF'G. CO.
SANDUSKY, OHIO, U. S. A.

Rumsey Electrical M'f'r's' Co., 1211 Filbert St., Philadelphia, Pa.
H. B. Coho & Company, 114 Liberty St., New York.
C. A. Cotton, 129 Pearl St., Boston, Mass.
Thos. Muir & Son, Detroit, Mich.
Western Electrical Supply Co., St. Louis, Mo.
C. W. Hobson, Waco, Texas.
Kilbourne & Clark Co., 815-817 Second Ave., Seattle, Wash., Pacific Coast Agts.
A. M. Scarles, 1200 Fisher Bldg., Chicago, Ill.

Read Between The Lines

The real kernel of a subject is often found by reading between the lines.

Why Is It

in the face of all competition we have grown to be the greatest of all

repair houses? Why is it that armatures come for hundreds of miles past competitors' shops to us to be wound?

Why is it that the points to which our commutator armature coils and fields go are limited only by the great oceans?

Try us once and you will know why

Cleveland Armature Works

Cleveland, Ohio

New STANDARD Dry Battery

FLASH LIGHTS $2.00

GAS LIGHTERS that will last a year without renewal of battery .·. $1.50

OTHER GOOD AND USEFUL DEVICES OPERATED WITH DRY CELLS

William Roche

42 VESEY STREET NEW YORK CITY

CLASSIFIED INDEX

(*Continued from page 66.*)

Pumps (Electric Driven).
Stilwell-Bierce & Smith-Vaile Co.

Rails.
Johnson, Charles F.

Rail-Bonds.
Roebling Sons Co., John A.

Railway Car Lighting.
Consolidated Railway, Electric Lighting & Equipment Co.

Railway Specialties (Electric).
Bunnell & Co., J. H.
Central Electric Co.
Continuous Rail Joint Co. of America.
Electric Appliance Co.
General Electric Co.
Kinsman Electric & Railway Supply Co.
Stuart-Howland Co.
Westinghouse Electric & Mfg. Co.

Reflectors.
Frink, I. P.
Wheeler Reflector Co.

Repairs.
Chicago Edison Co.

Replacers Incandescent Lamp.
Incandescent Electric Light Manipulator Co.

Rheostats.
Cutler-Hammer Mfg. Co.
Cutter Electrical & Mfg. Co.
Gen'l Incandescent Arc Light Co.

Schools.
American School of Correspondence.
Electrical Engineer Institute of Correspondence Instruction.
Internat'l Correspondence Schools.

Seals.
The Schwerdtle Stamp Co.

Slate.
Bonville, Edward.

Sockets.
H. T. Paiste Co.

Soldering Sticks and Paste.
Allen & Co., L. B.
Burnley Battery & Mfg. Co.

Specialties.
Bonville, Edward.
Boston Electric Co.
Crouse-Hinds Electric Co.
Electric Contract Co.
Gen'l Incandescent Arc Light Co.
Incan. Elec. Light Manipulator Co.
Lyon Metallic Mfg. Co.
Marshall-Sanders Co.
Phelps Co.

Steam Heating.
American District Steam Co.

Steam Specialties.
Lunkenheimer Co., The.
Robertson & Sons, Jas. L.
U. S. Mineral Wool Co.

Steel Spring Wire.
Barnes Co., The Wallace.
Cary Spring Works.

Steel Stamps.
The Schwerdtle Stamp Co.

Stencils.
The Schwerdtle Stamp Co.

Storage Batteries.
American Battery Co.
Electric Storage Battery Co.
Gould Storage Battery Co.
Helios-Upton Co.
National Battery Co.
Reuterdahl Electric Co.
Smith Storage Battery Co.

Switchboards.
Bossert Electric Construction Co
Bullock Electric Mfg. Co.
Ericsson Telephone Co.
Eyanson & Co., Geo. T.
Fort Wayne Electric Works.
Gen'l Incandescent Arc Light Co
Kutsch, L. W.
Wagner Electric Mfg. Co.
Western Electric Co.

Switches, Etc.
Central Electric Co.
Cutter Electrical & Mfg. Co.
Eyanson & Co., Geo. T.
General Electric Co.
Gen'l Incandescent Arc Light Co
Hart & Hegeman Mfg. Co.
Hart Mfg. Co.
Hill Electric Co., W. S.

Switches, Etc.
Marshall-Sanders Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Tape and Splicing Compound.
Massachusetts Chemical Co.
Okonite Co.

Telegraph Supplies.
Bunnell & Co., J. H.
Stuart-Howland Co.

Telephones.
American Bell Telephone Co.
American Electric Telephone Co.
Central Electric Co.
Central Telephone & Electric Co.
De Veau Telephone Mfg. Co.
Ericsson Telephone Co.
Farr Telephone & Construction Supply Co.
Kellogg Switchboard & Supply Co.
New York Telephone Co.
North Electric Co.
Spencer Electrical Co.
Stanley & Patterson.
Stromberg-Carlson Telephone Mfg. Co.
Viaduct Mfg. Co.
Vought-Berger Co.
Western Telephone Mfg. Co.

Testing Bureau.
Lamp Testing Bureau

Ties, Cross-Arms, Brackets, Pins, Climbers, Etc.
Central Electric Co
Donnelly, John
Klein & Son, Mathias.
Lindsley Brothers Co.
Standard Pole & Tie Co.

Tools.
Morse Twist Drill Co.
Smith & Hemenway Co.
Utica Drop Forge & Tool Co.

Transformers.
Christensen Engineering Co.
Fort Wayne Electric Works
New York & Ohio Co.
Stanley Electric Mfg. Co.
Vindex Electric Co.
Wagner Electric Mfg. Co.
Warren Electric & Specialty Co.

Transformers.
Western Electrical Supply Co
Westinghouse Electric & Mfg. Co.

Turbine Governors.
Lombard Water-Wheel Gov. Co.
Lunkenheimer Co., The

Valves.
Lunkenheimer Co., The.

Varnish, Insulating.
Massachusetts Chemical Co.
Sterling Varnish Co.

Vises.
Utica Drop Forge & Tool Co.

Water-Wheels.
Leffel & Co., Jas.
Risdon-Alcott Turbine Co.
Stilwell-Bierce & Smith-Vaile Co.

Water-Wheel Governors.
Lombard Water-Wheel Gov. Co.

Whistles.
Lunkenheimer Co., The.

Wires and Cables.
American Electrical Works.
American Insulated Wire & Cable Co.
Atlantic Insulated Wire & Cable Co.
Bridgeport Brass Co.
Central Electric Co.
Chicago Insulated Wire Co.
Collyer Insulated Wire Co.
Crescent Insulated Wire and Cable Co.
Driver-Harris Wire Co.
Eastern Electric Cable Co.
Electric Appliance Co.
Empire Wire Co.
General Electric Co.
Hazard Mfg. Co.
India Rubber and Gutta Percha Insulating Co.
Montauk Fire-Detecting Wire Co.
National Conduit & Cable Co.
National India Rubber Co.
New York Insulated Wire Co.
Okonite Co., The.
Phillips Insulated Wire Co.
Roebling's Sons Co., John A.
Safety Insulated Wire & Cable Co.
Simplex Electrical Co.
Standard Underground Cable Co
Western Electric Co.

Automatic Telephones and Switchboards Manufact'd by the

AUTOMATIC ELECTRIC CO.
CHICAGO . . . U. S. A.

Juniper Poles
RECOGNIZED as the best pole for trolley lines
THE STANDARD POLE & TIE CO.
502 Venezuela Bldg., NEW YORK CITY

IDAHO WISCONSIN MICHIGAN
CEDAR POLES AND TIES
JOHN H. FOWLER FOWLER-JACOBS CO.
YARDS
WASHBURN, WIS.
PLUMMER, WIS.
BRULE, WIS.
VAN BUSKIRK, WIS.
URSON, WIS.
GENERAL OFFICE
1705 FISHER BUILDING
CHICAGO
BRANCH OFFICES
WASHBURN, WIS., AND SPOKANE, WASH.

Monoplex intercommunicating Telephone, $4.00 each
The simplest and most reliable instrument ever placed on the market. Absolutely guaranteed for one year. Diagram and directions are plain and anybody can install them. Send for circular describing three systems and advantages of our switchless instruments. Price—
2 Station Instrument, $4.00 each
11 " " 4.50 "
2 end " 2.50 "
ATWATER KENT MFG. WKS., 118 N. 6th St., Phila., Pa.

THE **VIADUCT** CO
BALTIMORE, MAKE
TELEPHONES
AND EVERYTHING ELECTRICAL

THE BEST POLES IN THE WORLD
Southern Cedar Poles
D. W. PHELAN NO ROTTEN BUTTS TRY THEM 277 Broadway NEW YORK

FARR TELEPHONES
FOR PRIVATE LINES EXCHANGES COUNTRY LINES AND FACTORIES
TELEPHONE SUPPLIES, BRACKETS, WIRE & INSULATORS
FARR TELEPHONE AND CONST. SUPPLY CO.
118 & 120 W. Jackson Blvd. - - CHICAGO

CEDAR POLES
LINDSLEY BROTHERS COMPANY
536 Tribune Bldg., CHICAGO
MENOMINEE, MICHIGAN (main distributing yards)
PORTLAND, OREGON, and SPOKANE, WASHINGTON
WHOLESALE PRODUCERS
50-Foot to 80-Foot Poles Our Specialty

The Pioneer Western Telephone Construction Company's Business
is being reorganized by the best talent known to the art of telephony. The Highest Mechanical Skill and Most Scientific Electrical Engineering is now being employed to Create New Designs and Improve Upon Past Methods. It is announced that the
Western Telephone Mfg. Co.
will make its name a Synonym for
PERFECTION IN TELEPHONE APPARATUS
Factories: Winthrop Harbor, Ill. Offices: Chicago, Ill.
☞ Ask about our New Lamp Clearing-Out System.

KLEIN'S CLIMBERS

Linemen's Tools
Catalogue Free. Send for one.
MATHIAS KLEIN & SONS
87-89 W. Van Buren St., CHICAGO, ILL.

TOUR TO CALIFORNIA

Under the Personally-Conducted System of the Pennsylvania Railroad

The second Pennsylvania Railroad Personally-Conducted Tour to California for the present season will leave New York and Philadelphia on the Golden Gate Special, February 19, going via Cincinnati, New Orleans, San Antonio and El Paso to Los Angeles and San Diego. Three days will be spent in New Orleans, during the Mardi-Gras festivities. Should a sufficient number of passengers desire to travel under the care of a Tourist Agent and Chaperon, a delightful month's itinerary in California has been outlined; and a returning itinerary to leave San Francisco March 28, visiting Salt Lake City, Glenwood and Colorado Springs and Denver, arriving in New York April 6. Rate, $275 from all points on the Pennsylvania Railroad east of Pittsburg, covering all expenses of railroad transportation, side trips in California, and berth and meals going on the special train. No hotel expenses in California are included. Tickets are good for return within nine months, but returning cover transportation only. For detailed itinerary apply to Ticket Agents, or address Geo. W. Boyd, Assistant General Passenger Agent, Broad Street Station, Philadelphia, Pa.

Hawkins'
New Catechism of
ELECTRICITY

A Practical Treatise.
Price $2.00.

This is a book of 550 pp., full of up-to-date information. 300 illustrations. Handsomely bound in red leather, pocket-book form. size 4½ x 6½, with titles and edges in gold. Price $2.00, post-paid. Send all orders to

Electrical Review Publishing Co.
13 Park Row, New York.
Box 339.

American Beauties

Bell Express Style
One to two hundred to the operator
American Electric Telephone Co.
Chicago, Ill.

-IN-
TEXAS
THEY WANT GOOD TELEPHONE APPARATUS. THIS IS EVIDENCED BY THE FACT THAT THERE ARE OVER
15,000 S&C TELEPHONES
AND 44 EXCHANGES
USING STROMBERG-CARLSON APPARATUS
EXCLUSIVELY
WRITE US FOR FURTHER PARTICULARS.

D. C. LINCO, State Representative,
Fort Worth, Texas.

It is not so much what you pay for telephone apparatus, but to get what you ought to have is the point. In other words, quality counts.

STROMBERG-CARLSON TELEPHONE MFG. CO.
Rochester, N. Y. Chicago, Ill.

THIS Trade-Mark DE VEAU

Complete New Catalogue, 129 pages, mailed upon request.

is in itself the

Strongest Possible Guarantee

that ever went out with Telephone Apparatus.

It guarantees the material.

It guarantees the construction.

It guarantees satisfaction.

DeVEAU Long Distance and Interior Telephones
DeVEAU Patented Automatic Switchless Telephones
DeVEAU Patented Flush Telephones
DeVEAU Restoring and Non-Restoring Switchboards
DeVEAU Patented Intercommunicating Telephones
DeVEAU Central Energy Telephones and Switchboards
DeVEAU Pat. All Metal Intercommunicating Telephones
DeVEAU Patented All Metal Hotel Telephones

DeVEAU Telephone Manufacturing Company
27 Rose St. New York

NORTH

We Don't Want the Earth

Merely give us your ear and consider our

DIVIDEND PAYERS.

Telephones that never wear out. Magnets that never deteriorate. Carbon that never disintegrates. Toll Boards that take care of themselves. Switchboards that never give trouble. Multiple Boards for exchanges—all sizes. Current Protectors that never fail.

Maintenance Repair EXPENSE Reduced to the Minimum

THAT'S WHY PATRONS UPHOLD

The North Electric Co.

Write for Catalogue.
145-155 St. Clair Street, CLEVELAND, O.
Chicago Office, 1511 Monadnock Block.

Switch-boards of Quality

THE VOUGHT-BERGER CO.
MAKERS OF
Telephones & Switchboards
LA CROSSE, WIS., U. S. A.
Get a Pendant

BELL of Baraboo Wis.

Telephones and Switchboards remodeled on approved lines.

A good 'Phone at the right price. We promote or build.

INTERIOR TELEPHONES
Intercommunicating, Central Battery and Central Coil System
Patented Jan. 4th, 1898; May 9th, 1899, and Aug. 15th, 1899. *Cheapest outfit to maintain, but not cheap as to first cost.*
SPENCER ELECTRICAL CO.
163 Greenwich St. NEW YORK

TELEPHONE SERVICE IS THE QUICKEST MESSENGER

Rates in Manhattan:

Residence
from $4 a month.
Business
from $5 a month.

One-Year Contracts.
Monthly Payments.

New York Telephone Co.
15 Dey Street.
111 West 38th Street.
220 West 124th Street.

OUR foremen require of their workmen, not haste, but constant and infinite pains. That added to the design, is the reason why the finished

Kellogg Telephone

is the despair of competitive makers. That is the reason for such wonderful nicety and precision of sound transmitting on Kellogg Telephones that *you can almost hear the punctuation points* and all but hear one's very smile. That is why the Kellogg Transmitter is guaranteed better than the Bell Solid Back. : : : :

Kellogg Switchboard and Supply Company

GREEN AND CONGRESS STREETS, CHICAGO

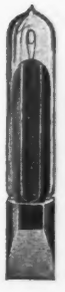
New York Cleveland Philadelphia

Edison Telephone Lamps

ARE THE

STANDARD FOR VISUAL SIGNALS

They save the Exchange time and money because every lamp is perfect—sure to fit—sure to burn. The life is extremely long—running into years. Be sure to get the Edison.



EDISON DECORATIVE & MINIATURE LAMP DEPARTMENT

GENERAL ELECTRIC COMPANY, HARRISON, N. J.

NEW YORK OFFICE: 44 BROAD STREET SALES OFFICES: ALL LARGE CITIES

For the Consumer

the attractive commercial factor of the

Nernst Lamp

lies in the economy of current

For the same illumination the operating expense is about half that of incandescents, the efficiency is equal to that of the enclosed arc lamp.

For full particulars ask your

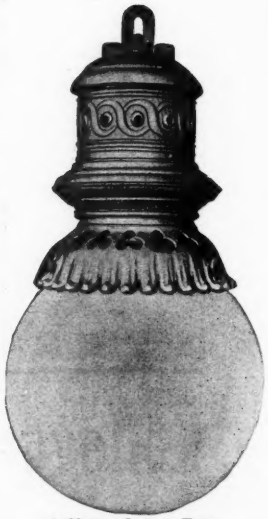
Electrical Supply Dealer

Or write for illustrated booklet No. 2

Nernst Lamp Co.

General Offices, Pittsburgh, Pa.

6 Glower Outdoor Type Nernst Lamp.



6 Glower Indoor Type Nernst Lamp.

Sales Offices: New York, 120 Broadway; Boston, 131 State Street; Philadelphia, 202 Real Estate Trust Building

42,000 Personal Calls

By INTELLIGENT, WELL-DRESSED MEN

who know how to make friends, is the record offered by the subscription manager of the ELECTRICAL REVIEW for the twelve months of 1902.

It is not that this number is very large, but that the greatest proportion of calls were very well made that we believe we may consider it the most successful subscription campaign ever carried through by an engineering publication. The work embraced nearly every state in the Union, and in addition to general engineering lines included electric light stations, both central and isolated, railways, telephone exchanges, electrical supply houses, telegraphic engineers and other special electrical interests. Study these facts when you advertise.

We make no advance in rates this year.

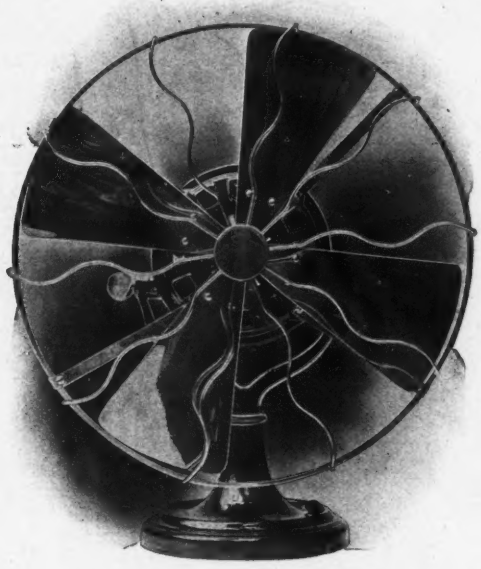
Electrical Review

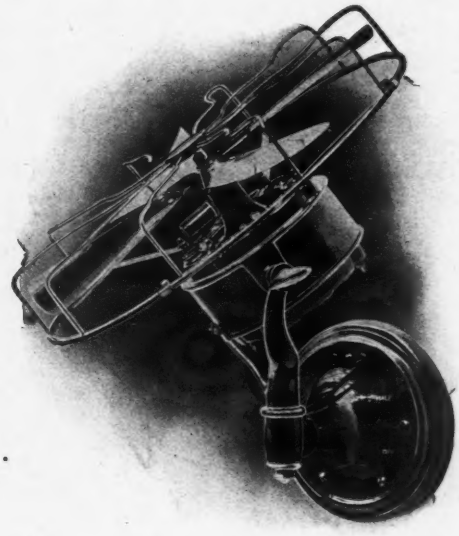
CHICAGO—40 Dearborn St. 13 PARK ROW, NEW YORK LONDON—42 Old Broad St.

Westinghouse Fan Motors

Season 1903

For Either Alternating or Direct-Current Circuits





High Starting Torque
Low Wattage
Variable Speed

The same motor may be used over a wide range of voltages

Bracket or Desk Types
12 or 16-inch sizes

Mounted on swivel and trunnion, enabling the fan to be turned in any direction or given any elevation

Complete Stock of all Styles

Westinghouse Electric & Mfg. Co.

Pittsburg, Pa.

New York, Atlanta, Dallas, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Los Angeles, Minneapolis, Philadelphia, Pittsburg, St. Louis, San Francisco, Syracuse, Seattle, Salt Lake City, Denver, Mountain Electric Co., Canada, Ahearn & Soper, Ltd., Ottawa, Mexico, G. & O. Braniff & Co., City of Mexico.

TRADE MARK

CRESCENT INSULATED WIRE & CABLE CO. TRENTON, N.J.

CRESCENT RUBBER INSULATED WIRES AND CABLES

National Code Standard

CRESCENT INSULATED WIRE AND CABLE CO.

New York Office, 53 Barclay St. - Main Office and Factory, TRENTON, N. J.

Chicago Insulated Wire Company

High-Grade Weather-Proof, Magnet, Office, Annunciator Wire & Galvanized Steel Strand

Chicago Office 15 Marine Building

Factory Sycamore, Illinois

Frink's Fixtures

Reflect More than Light.

They reflect credit on your work.

Their extreme power, perfect diffusion and workmanlike finish, are unequaled. As the visible part of your work, it is upon the service and appearance of the fixtures that your business reputation rests. Our reputation for manufacturing the best reflectors, has been maintained for over forty years; in protecting it, we protect yours.

3 **I. P. FRINK, 551 PEARL ST., NEW YORK CITY.**

IT WILL PAY YOU TO ASK US FOR PRICES AND SAMPLES OF

WEATHERPROOF COPPER WIRE

WHENEVER YOU ARE IN THE MARKET A LARGE STOCK CARRIED

American Insulated Wire and Cable Co.

241-247 SO. JEFFERSON ST.

CHICAGO

EMPIRE WIRE CO.

100 WILLIAM ST., NEW YORK

BARE AND TINNED COPPER WIRE MAGNET WIRE

ROEBLING

Insulated Cables

Rubber Covered Wire

Magnet Wire

Lamp Cord

Bare Copper Wire

John A. Roebling's Sons Co., Trenton, N. J.

NATIONAL ELECTRICAL CODE STANDARD

WEATHER-PROOF TRADE MARK "O.K." LINE AND HOUSE WIRES

"O. K." WEATHER-PROOF, SLOW-BURNING WEATHER-PROOF, AND SLOW-BURNING WIRE.

PRICES AND SAMPLES ON APPLICATION.

PHILLIPS INSULATED WIRE CO.

OFFICE AND FACTORY: PAWTUCKET, R. I.

The Lunkenheimer "DURO" Blow-off Valve

A Valve with self-cleansing seat, simple and practical in construction and entirely different from all other blow-off valves in the market.

The way the "DURO" is built, no scale or sediment can lodge on the seat. If you want a practical success and a Valve that will last as long as the boiler, you want the "DURO". No boiler should be without one.

Made in screw ends, flange ends and screw and flange ends. Made in 2, 2½, and 3-inch sizes. Every Valve tested, inspected and warranted to give complete satisfaction. Specify the "DURO" and order one from your dealer.

Write for catalogue of brass and iron steam specialties and engineering appliances of superior quality.

THE LUNKENHEIMER COMPANY SOLE MAKERS

CINCINNATI, OHIO, U. S. A.

Branches

NEW YORK, 26 Cortlandt Street

LONDON, 35 Great Dover Street

18

SPEER CARBON COMPANY

ST. MARYS, PA.

MANUFACTURERS OF MOTOR AND GENERATOR BRUSHES OF ALL KINDS

EXCHANGE TELEPHONES.

No. 251 Cabinet Type. In compact form. An attractive looking 'phone and a highly satisfactory working one.

Ericsson Telephone Co.

"Standard of the World"

UTICA DROP FORGE & TOOL COMPANY

Manufacturers of Nippers and Plyers

SMITH & HEMENWAY COMPANY

Manufacturers of Cutlery and Hardware Specialties.

296 BROADWAY, NEW YORK CITY.

In the Electrical Field "trouble" and "poor material" are synonymous terms, so that when Electricians complain of "trouble" with insulated wires and cables, it is a sure sign they are not using

"OKONITE"

the standard for rubber insulation which has no equal.

Candee wires and potheads, Okonite and Manson Tapes are the very best to be obtained.

Prices and further information cheerfully furnished

The Okonite Company, Ltd.

253 Broadway, New York

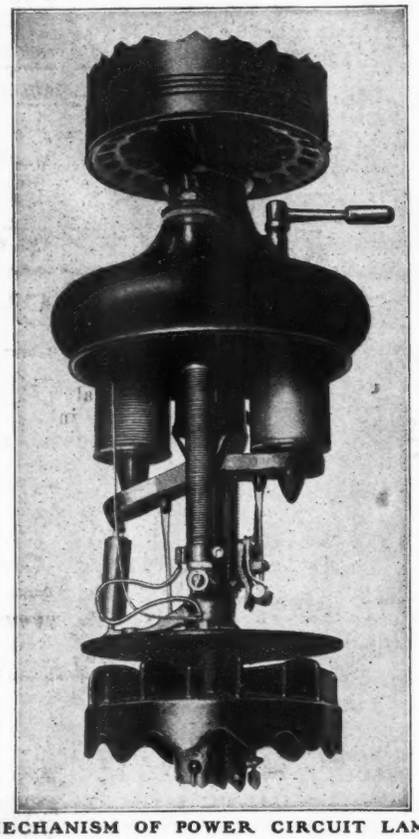
OKONITE
TRADE MARK.

Willard L. Candee
H. Durant Cheever
} Managers

OKONITE
TRADE MARK.

"WOOD" ENCLOSED ARC LAMPS

FOR POWER CIRCUITS



MECHANISM OF POWER CIRCUIT LAMP

Inspection of the interior of an arc lamp often reveals its true worth. Flimsy devices for cheapening cost of manufacture, make-shift methods of assembling parts and the use of inferior materials betray the worthlessness of an arc lamp conclusively.

"WOOD" arc lamps present the same high-grade appearance inside and outside. Every detail of construction and every detail of design is given the best attention of experienced engineers and skilled workmen. The result is a lamp that will stand inspection from suspension top to lower carbon holder with the case on or off and its operation is not inconsistent with its appearance.

Fort Wayne Electric Works

Manufacturer of "Wood" Systems

Main Office and Factory, Fort Wayne, Ind.

188

INDEX TO ADVERTISERS.

A

Abbott, Eugene B. 43
Adams-Bagnall Electric Co.
Akron Electrical Mfg. Co. 28
Allen & Co., L. B. 30
Allis-Chalmers Co. 41
Alphaduct Mfg. Co. 39
American Battery Co. 30
American Bell Telephone Co 46
American Carbon & Battery Co.
American Circular Loom Co. 8
American Conduit Co 15
American District Steam Co. 43
American Electrical Heater Co. 6
American Electric Telephone Co. 47
American Electrical Works. 1
American Engine Co. 41
American Insulated Wire & Cable Co. 52
American Steel & Wire Co. 10
American Vitrified Conduit Co. 14
Arnold Electric Power Station Co. 45
Ashcroft Mfg. Co. 39
Atlantic Insulated Wire & Cable Co. 42
Atwater Kent Mfg. Works 47
Automatic Electric Co. 46
Automatic Time Stamp Co. 49

B

Babcock & Wilcox Co. 43
Baker & Co. 30
Baker & Co., W. E. 45
Baker, Jos. B. 45
Ball & Wood Co. 41
Banner Electric Co.
Barnes Co, The Wallace.
Barron & Co., Jas. S.
Barstow, W. S. 45
Bates & Bro., D. L. 21
Bell Telephone Mfg. Co. 47
Biddle, James G. 39
Big Four R. R. 42
Billings & Spencer Co.
Bishop Gutta-Percha Co 1
Blake, M. J. & M. 43
Bossert Electric Construction Co. 8
Boston Electric Co. 39
Brady, T. H. 14
Bridgeport Brass Co. 1
Bristol Co. 1
Brookfield Glass Co. 42
Browning Mfg. Co. 27
Bryan-Marsh Co.
Buckeye Electric Co.
Bunnell & Co., J. H 4
Burnley Battery & Mfg. Co 43

C

Cahoon, James Blake. 45
Camp Co., H. B. 15
Cary Spring Works. 26
Case Bros 39
Central Electric Co. 3
Chicago Edison Co 28
Chicago Fuse Wire Mfg. Co.
Chicago Insulated Wire Co. 52
Christensen Engineering Co. 28
Cleveland Armature Works.
Cobo & Co., H. B. 20
Coleman Mfg. Co., The.
Collyer Insulated Wire Co. 10
Colonial Fan & Motor Co.
Columbia Incandescent Lamp Co.
Columbia Electric & Mfg. Co. 43
Consolidated Engine-Stop Co
Consolidated Railway Electric Lighting & Equipment Co. 21
Consolidated Safety Valve Co.
Consumers' Carbon Co. 26
Continuous Rail-Joint Co. of America. 5
Corson, Wm. R. C. 45
Crescent Insulated Wire and Cable Co. 52
Crocker-Wheeler Co.
Crouse-Hinds Electric Co 2
Cutler-Hammer Mfg. Co. 13
Cutter Co. 1

D

D. & W. Fuse Co. 3
Diamond Meter Co.
Dickey-Sutton Carbon Co. 26
De Veau Telephone Mfg. Co. 46
Diehl Mfg. Co. 20
Dixon, Jos., Crucible Co. 13
Donnelly, John 42
Doubleday-Hill Electric Co. 22

D

Driver-Harris Wire Co.
Duncan Electric Mfg. Co. 4
Dustin Co., Chas. E 40
Duvall, E. S., Jr. 39

E

Eastern Electric Cable Co. 10
Eck Dynamo & Motor Works. 28
Economical Electric Lamp Co. 5
Edison Decorative & Miniature Lamp Department. 30
Edison Mfg. Co. 6
Electric Appliance Co. 1
Electric Contract Co. 7
Electric Gas Lighting Co.
Electric Motor & Equipment Co. 7
Electric Storage Battery Co. 13
Electric Launch Co. 28
Electrical Engineer Institute of Correspondence Instruction. 42
Elwell-Parker Electric Co. 28
Empire Wire Co. 52
Ericsson Telephone Co. 52
Eureka Electric Color Co. 39
Ewing-Merkle Electric Co.
Eyanson & Co., Geo. T. 6

F

Farr Telephone & Construction Supply Co. 49
Fahnestock Transmitter Co. 49
Feilden Publishing Co., Ltd. 4
Field, C. J. 14
Fleming Slate Co. 42
For Sale. 42
Fort Wayne Electric Works. 12
Fowler, John H. 46
Frink, I. P. 52

G

General Electric Co. 27
General Incandescent Arc Light Co. 19
Gest, G. M. 14
Gould Storage Battery Co. 3
Graton & Knight Mfg. Co. 40
Green Fuel Economizer Co. 16

H

Hanchett, Geo. T. 45
Hancock Inspirator Co
Hartford Steam Boiler Inspection & Insurance Co.
Hart & Hegeman. 23
Hart Mfg. Co. 8
Hayden & Derby Mfg. Co.
Hazard Mfg. Co. 10
Helios-Upton Co. 6
Hill, W. S., Electric Co. 20
Hobart Electric Mfg. Co. 1
Hubbell, Harvey 14
Hungerford Electric Mfg. Co. 23
Hunt Co., C. W. 42
Hunter Fan & Motor Co. 20

I

Incandescent Electric Light Manipulator Co. 46
Independent Incan. Lamp Co. 24,25
India Rubber & Gutta Percha Insulating Co 8,10
International Correspondence Schools
Inventive Age Publishing Co. 26

J

Jeffrey Mfg. Co 43
Jewell Electrical Instrument Co. 13
Johns-Manville Co., H. W. 5
Johnson, Chas. F. 40

K

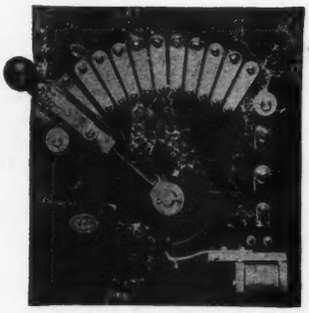
Kellogg Switchboard and Supply Co. 49
Kelly Engineering Co., The John F. 45
Keystone Electric Co. 20
Kinsman Electric and Railway Supply Co 7
Klein & Sons, Mathias. 46
Knott Apparatus Co., L. E. 22
Knowles, Edward R. 45

L

Lamp Testing Bureau. 40
Lawrence Hall Electric Co. 16
Leffel & Co. James. 17
Le Valley Vitae Carbon Brush Co.
Lombard Governor Co. 17
Lowell Model Co 39
Lunkenheimer Co. 53
Lyndon, Lamar. 45
Lyon Metallic Mfg. Co. 38

(Continued on page 16.)

C & H



MOTOR-SPEED REGULATORS WITH AUTOMATIC RELEASE

ANY H. P. ——— ANY VOLTAGE

The Cutler-Hammer Mfg. Co.
Milwaukee, Wis.

Chicago	New York	Pittsburg
1232 Monadnock Bldg.	136 Liberty St.	319 Frick Bldg.

QUALITY COUNTS

That is why we are receiving more orders than ever before; that is why Wheeler Shades are specified in preference to all others; and that is why the buyer is willing to pay us a higher price.

WHEELER REFLECTOR CO.
156 PEARL STREET, BOSTON
Foreign Department, 88 Maiden Lane, New York City

CARBONS and lamp filaments baked with Dixon's No. 1365 Graphite do not lose their carbon. Furnished in any degree of fineness. Ask for booklet 48.
JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J.

JEWELL INSTRUMENTS

For Direct Current only, are used by discriminating engineers

Illuminated Dial Instrument

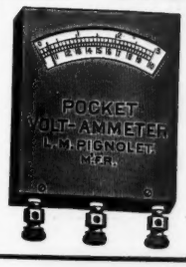
The Illuminated Dial Switchboard Instruments are built in iron cases and have rear connections, ½ inch in diameter and 3½ inches long. Adjustable dials operated by micrometer screw.

Jewell Electrical Instrument Company
61 and 63 Union Park Court, cor. Carroll Ave. - - Chicago, Ill., U. S. A.

ANY CANDLE POWER — STAR — STANDARD ELEC. MANF'G CO. NILES, OHIO, U.S.A. — ALL VOLTAGES

This Label on incandescent lamps guarantees best quality lamps

STANDARD ELECTRIC MFG. CO., Niles, Ohio



Voltmeters, Ammeters, and Volt-Ammeters . . .

POCKET SIZE, VARIOUS RANGES. ACCURATE, RELIABLE.

For General Measurements, Testing Storage and Primary Batteries, Circuits, Etc.

L. M. PIGNOLET,
Manufacturer of ELECTRIC INSTRUMENTS, and ELECTROTHERAPEUTIC APPARATUS.
78 Cortlandt Street, New York.

The Whitney Testing Set

here illustrated contains one of the most sensitive D'Arsonval galvanometers made and its resistance coils are guaranteed adjusted to ¼ of 1 per cent. The range is 0.01 ohm to 5 megohms.
Write for details and discounts.

Machado & Roller
203 Broadway, New York, N. Y.
General Agents of Whitney Electrical Inst. Co.

LIST PRICE, $38.00

THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA

MANUFACTURER OF THE

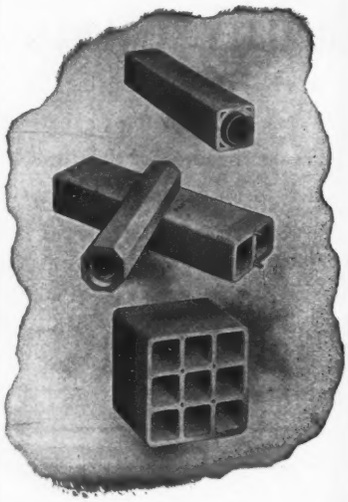
"Chloride Accumulator"

For Central Stations, Electric Railways, Isolated Lighting and Power Stations, Fire Alarm, Telegraph, Train Lighting, etc., etc.

PRICE LISTS AND DESCRIPTIVE BULLETINS FORWARDED UPON REQUEST

— Sales Offices —

Philadelphia:	New York:	Boston:	Chicago:	Baltimore:	St. Louis:	San Francisco:	Cleveland:	Havana Cuba:
Allegheny Ave. & 19th St.	120 Broadway	60 State Street	Marquette Bldg.	Continental Trust Bldg.	Wainwright Bldg.	Nevada Block	New England Bldg.	G. F. Greenwood, Manager 34 Empedrado Street



American Vitrified Conduit Co.

GENERAL OFFICE — Broadway-Maiden Lane Building, NEW YORK

Manufacturers of VITRIFIED GLAZED CONDUIT

MANHATTAN THIRD-RAIL INSULATOR

40,000 of this type Insulator furnished by us to Manhattan Railway Co. of New York

CONDUIT

FOR ELECTRIC LIGHTING—ELECTRIC RAILWAYS—ELECTRIC TRANSMISSION—TELEPHONE PURPOSES

ESTIMATES, SPECIFICATIONS, DESIGNS AND PLANS FURNISHED

G. M. GEST, EXPERT SUBWAY CONTRACTOR

BROADWAY CHAMBERS BLDG., 277 BROADWAY, NEW YORK. UNION TRUST BLDG., CINCINNATI, OHIO

Look for this Trademark

On Flexible Conduits

FLEXIBLE TRADE EUREKA MARK CONDUIT

IT SIGNIFIES QUALITY

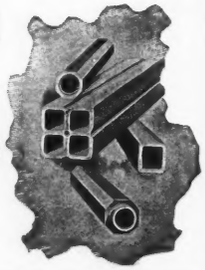
— The —

Rittenhouse-Miller Co.

923 Witherspoon Bldg.

Philadelphia

Vitrified Glazed Clay Conduits



MULTIPLE DUCTS SINGLE

LARGE FACTORIES, BEST CONDUITS, MODERATE PRICES.

Would Like to Figure with You on Conduits or Complete Subway System.

C. J. FIELD

Sole Agent for Conduit Factories.

29 Broadway, NEW YORK

Telephone, 5033 Broad.

THE HUBBELL UNIVERSAL ATTACHMENT PLUG

BASE SCREWS IN
CAP SNAPS ON

NO TWISTING OF THE WIRE

LATEST SIMPLEST BEST

HARVEY HUBBELL

Main Office and Factory

New York BRIDGEPORT, CONN. Chicago

THE BRADY MAST ARMS

T. H. BRADY, New Britain, Conn., U. S. A.

MANUFACTURER OF

Mast Arms, Pole and Swinging Hoods, House Brackets and other specialties for construction work

Catalogue and Prices Furnished on Application

ELECTRIC HEATING APPARATUS

OF EVERY DESCRIPTION

"Unit" Enamel Rheostats

The Simplex Electric Heating Co.

CAMBRIDGEPORT MASS.

Look Over, Please

the recent EXPORT and DOMESTIC NUMBERS (published the second issue of each month) of the Electrical Review and note how comprehensive the advertising pages are of the Standard Electrical Equipments and Products. The next EXPORT and DOMESTIC NUMBER appears May 9. Send copy to either office

40 Dearborn Street CHICAGO | 13 Park Row NEW YORK | 42 Old Broad Street, E. C. LONDON

New York & New Jersey Telephone Company
Perth Amboy, N. J.

LARGE PROPOSITIONS

Are Handled with Unequaled Facility by the Standard Vitrified Conduit Company

SINGLE AND MULTIPLE DUCT

Furnished Promptly in Quantities of any Magnitude

High-Grade Stoneware Clays

Modern Kilns

Perfect Machinery

An Experience that Proclaims a Mastery of the Art of Pottery Processing

STANDARD VITRIFIED CONDUIT COMPANY

UNDERGROUND CONDUIT, INSULATORS, AND SPECIAL CLAY PRODUCTS

39-41 Cortlandt Street, New York City

R. W. LYLE, President and General Manager — B. S. BARNARD, Secretary and Treasurer

American Conduit Co.

Manufacturers of

Bituminized Fiber Conduit (Patented)

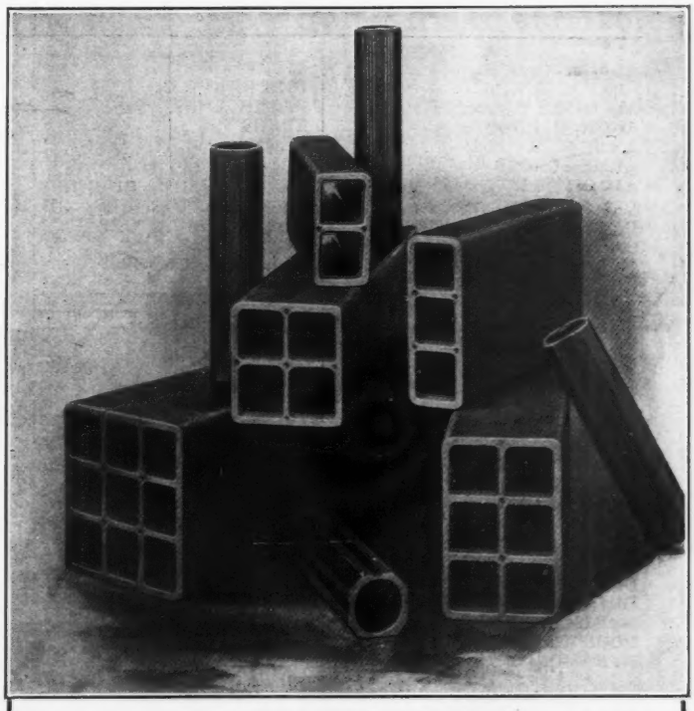
For UNDERGROUND ELECTRICAL WORK

Our Conduit is { ELECTROLYSIS-PROOF, NON-ABRASIVE, MOISTURE-PROOF, NON-CORROSIVE, CHEAPLY and RAPIDLY LAID } Insulation Test 66,000 Volts

We give you a perfect joint, which is self-aligning and makes each duct a continuous tube from manhole to manhole.

It will pay all those interested in subway construction to write us for particulars and prices before closing contracts for Conduit. State sizes and quantity desired.

Offices: 720 Arcade Building, PHILADELPHIA, PA.
822 Manhattan Building, CHICAGO, ILL.
336 Macy St., LOS ANGELES, CAL.
Factories: Chester, Pa., Chicago, Ill., Los Angeles, Cal.



THE H. B. CAMP CO.

170 Broadway, New York 85 Hartford Bldg., Chicago

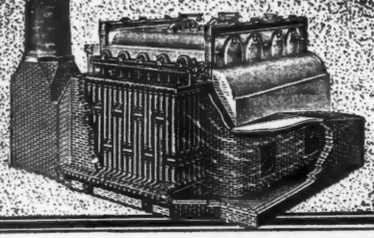
LARGEST MANUFACTURERS OF

VITRIFIED CLAY CONDUIT

FOR ELECTRIC WIRES

GREEN'S ECONOMIZER

SAVES 10 TO 20% IN FUEL



An item worth considering at the present price of coal

Special designs for ELECTRIC LIGHT and POWER PLANTS

See our free booklet "Green's Economizer" for detailed information

THE GREEN FUEL ECONOMIZER COMPANY

MATTEAWAN, N. Y.

Sole manufacturers in the U. S. A.

ALPHABETICAL INDEX.—*(Continued from page 12.)*

M

Machado & Roller..... 13
Magnet Wire Co..... 1
Manhattan Electrical Supply Co.. 42
Marshall, Wm..... 40
Marshall-Sanders Co..... 26
Massachusetts Chemical Co..... 9
McGill University..... 43
McIntire Co., The C..... 43
McTighe, Thos. J..... 45
Mead Cycle Co..... 42
Mechanical Boiler Cleaner Co..... 43
Menchen, Joseph P..... 43
Mica Insulator Co..... 30
Michigan Electric Co..... 42
Monarch Fire Appliance Co.....
Montauk Fire-Detecting Wire Co. 1
Morse Twist Drill Co..... 41
Munsell & Co., Eugene.....
Murdock, H. D..... 28
Murdock Parlor Grate Co..... 28

N

National Battery Co..... 6
National Carbon Co.....
National Conduit & Cable Co..... 1
National India Rubber Co..... 1
Nernst Lamp Co..... 50
New England Butt Co..... 10
New England Engineering Co..... 5
New England Motor Co..... 28
New York & Ohio Co.....
New York Cen. & Hudson Riv. R. R.
New York Insulated Wire Co..... 1
New York Telephone Co..... 46
North Electric Co..... 47

O

Okonite Co..... 1,11
Osborn-Morgan Co..... 39
Osburn Flexible Conduit Co..... 1
Ostrander, W. R. & Co..... 46
Otis Elevator Co..... 42

P

Pacific Electric Co..... 5
Pairpoint Corporation.....
Paiste Co., H. T..... 22
Parsell & Weed..... 42
Pennsylvania R. R..... 26
Phelan, D. W..... 46
Phœnix Glass Co..... 1
Phelps Co..... 39
Phillips, Eugene F., Bare and Insulated Wires..... 1
Phillips Insulated Wire Co..... 52
Pignolet, Louis M..... 13
Portland Co., The.....
Power Installation Co..... 45
Powers Co., The E. L..... 45
Prentiss Clock Improvement Co... 22

R

Rae, Frank B..... 45
Rappel, E. F. P..... 22
Reuterdahl, Arvid..... 45
Reuterdahl Electric Co..... 6
Risdon-Alcott Turbine Co..... 17
Rittenhouse-Miller Co..... 14
Robbins & Myers Co..... 21
Robertson & Sons, Jas. L..... 39
Roche, Wm..... 49
Roebling's Sons Co., John A..... 52
Rooney-Westbury Elec. Lamp Co. 30,40
Rossiter, MacGovern & Co..... 41
Runyon, F. O..... 45
Russell Tomlinson Elec Co..... 47

S

Safety Insulated Wire & Cable Co.. 10
Samson Cordage Works..... 39
Schapirograph Co..... 42
Schwerdtle Stamp Co..... 43
Shelby Electric Co..... 1,20
Siegrist Lubricator Co.....
Siggers & Siggers..... 39
Sills-Eddy Mica Co..... 6
Simplex Electrical Co..... 1
Simplex Electric Heating Co..... 14
Smith Storage Battery Co..... 6
Smith & Hemenway Co..... 17
Speer Carbon Co..... 52
Sprague Electric Co..... 19,30

(Continued on page 17.)

ELECTRICAL SUPPLIES OF ALL KINDS AND FOR ALL PURPOSES

A

ALARM CLOCKS
ALARM BOXES
ALCOHOL TORCHES
ANCHOR RODS
ANNUNCIATORS
ARMS—CROSS
AMMETERS

B

BATTERIES—ALL KINDS
BARS—TAMPING
BELLS
BLASTING MACHINES
BOLTS
BRACKETS—KEY
BRACES—CROSS ARM

C

CABLES
CARBONS
CARRIAGE BOLTS
CANT HOOKS
CIGAR LIGHTERS
CIRCULAR LOOM
COME ALONGS
COPPER WIRE
CROSS ARMS

D

DIGGING BARS
DRILLS
DRY BATTERIES
DOOR OPENERS
DYNAMOS

E

EXTENSION BELLS
ELECTRIC MATTING
ELECTRIC HEATING APPLIANCES
ELECTRIC GAS LIGHTING SUPPLIES

F

FIBRE
FIXTURE WIRE
FLASH LIGHTS
FUSES
FLEXDUCT

G

GAS LIGHTING BURNERS
GASOLINE TORCHES
GLASS INSULATORS
GLASS JARS
GLOVES—RUBBER
GONGS

OKONITE
TRADE MARK.

H

HEATING APPLIANCES
HERCULES BATTERIES

I

INDUCTION COILS
INSULATING MATERIAL
INSULATORS—GLASS, PORCELAIN

J

JARS—BATTERY
JOINTS—AMERICAN

K

KEYS—TELEGRAPH
KNIFE SWITCHES

L

LAMPS—BATTERY
LAG SCREWS
LINEMEN'S TOOLS
LOCUST PINS
LIGHTNING ARRESTERS

M

MATTING—ELECTRIC
MAGNET WIRE
MAXSTADT FUSES
MEDICAL BATTERIES
MOTORS

N

NATIONAL BATTERIES
NOVELTIES

O

OAK PINS
OAK BRACKETS
OFFICE WIRE
OKONITE PRODUCTS

P

PINS—LOCUST, OAK, STEEL
PLIERS
POLE STEPS
PORCELAIN INSULATORS
PUSH BUTTONS

Q

QUICK SILVER
QUICK DELIVERIES

R

RELAYS—TELEGRAPH
RODS—VULCANITE FIBRE
RUBBER GLOVES

S

SAFETY BELTS
SCREW DRIVERS
SCREWS
SOUNDERS—TELEGRAPH
SOLDER
SOLDERING SALTS
SPEAKING TUBES
STORAGE BATTERIES
SWITCHBOARDS

T

TAPE—OKONITE AND MANSON
TELEGRAPH INSTRUMENTS
TINSEL CORD
TUBING—HARD RUBBER
TELEPHONES

U

UNDERGROUND CONDUITS

V

VULCANIZED FIBRE
VOLTMETERS

W

WATCHMEN'S CLOCKS
WIRE—ALL KINDS
WINDOW SPRINGS
WIRE—OKONITE

X

X-RAY OUTFITS

Y

YALE LOCK SWITCHES

Z

ZINCS FOR BATTERIES

PROMPT SHIPMENTS RIGHT PRICES CAREFUL ATTENTION

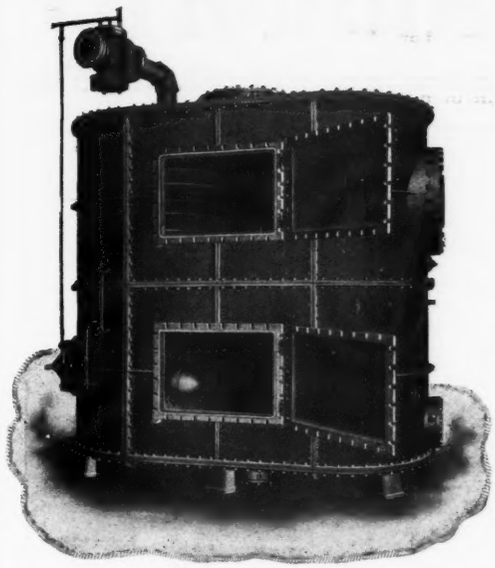
THE LAWRENCE-HALL ELECTRIC COMPANY

F. D. LAWRENCE, President and Treasurer
WM. ALBERT HALL, Vice-President and Secretary

ELECTRICAL SUPPLIES

213 West Fourth Street
CINCINNATI, OHIO

Saves FUEL—Saves BOILERS



A Stilwell Feed Water Heater is an important adjunct to steam power plants, because for every 10 degrees added to the temperature of feed water, about 1 per cent of the total cost for fuel will be saved. 210 degrees is easily obtainable with sufficient exhaust steam, as every facility is provided for bringing the steam and water together in such a way as to heat it to the highest possible temperature.

At the same time the water is freed from scale-producing elements, keeping the boilers free from scale and adding to their life.

We also make Steam, Power and Electric Pumping Machinery, Jet and Surface Condensers, Air Compressors, Victor Turbines, Oil Mill Machinery and Filter Presses.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY

NEW YORK: 141 Broadway PHILADELPHIA: 619 Arch Street CHICAGO: 311 Dearborn Street
NEW ORLEANS: 304 Hennen Building CLEVELAND: 1116 New England Building
BALTIMORE: 1507 Continental Trust Building BOSTON: 73 Oliver Street SAN FRANCISCO: 11-13 First Street
Sales Agents: FREDERIC NELL, 97 Queen Victoria St., London, England E. F. AUSTIN, Smith Block, Pittsburg

Dayton, Ohio, U. S. A.

TURBINES

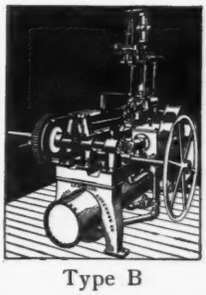
UPRIGHT AND HORIZONTAL
For ELECTRIC POWER and LIGHTING PLANTS

RISDON TURBINE
gives the highest full gate results of any Turbine ever made.

ALCOTT HIGH DUTY TURBINE
High speed and efficiency. Great strength.
Close regulation and steady motion.

TAYLOR SLEEVE GATE TURBINE
The largest power ever obtained from a wheel of the same diameter.

RISDON - ALCOTT TURBINE CO.
Write for Catalogue. MOUNT HOLLY, NEW JERSEY, U. S. A.



Type B

OUR
Water Wheel Governors
ARE THE
Standard of the World

Twelve types controlling 400,000 horse-power are in use.
Write for catalogue and list of several hundred plants where they are in use.

The Lombard Governor Co.
36 WHITTIER ST., BOSTON, MASS.

ALPHABETICAL INDEX.

(*Continued from page 16*)

S

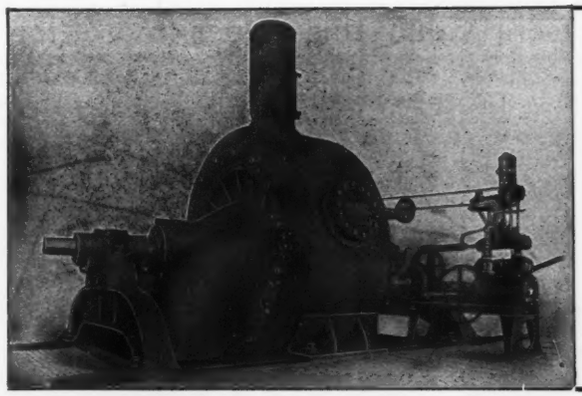
Standard Electric Mfg. Co..... 13
Standard Paint Co..... 30
Standard Pole & Tie Co..... 46
Standard Underground Cable Co.. 1
Standard Vitrified Conduit Co..... 15
Stanley Electric Mfg. Co..... 1
Stanley Instrument Co..... 19
Stanley & Patterson..... 43
Stanton, Le Roy W..... 45
Sterling Electrical Mfg. Co..... 26
Sterling Varnish Co..... 30
Stilwell-Bierce & Smith-Vaile Co.. 17
Stirling Co..... 43
Storey Motor & Electric Co.....
Stow Manufacturing Co..... 27
Stromberg-Carlson Telephone Mfg. Co 47
Stuart-Howland Co.....
Swedish-American Telephone Co.. 46

T

Thresher Electric Co..... 29
Toomey, Frank..... 42
Tulley & Co., Henry C..... 21

U

U. S. Battery Co..... 1
U. S. Mineral Wool Co. 6
University of Wisconsin..... 43
Utica Drop Forge & Tool Co..... 52



SAMSON TURBINE

ESPECIALLY ADAPTED TO DRIVE
ELECTRICAL MACHINERY
SPECIAL FEATURES:
High Efficiency at all Gateages
Balanced Gate, Steady Motion
High Speed, Great Strength

These Turbines Allow Exceedingly Close Speed Regulation. Write Dept. V for Catalog.

JAMES LEFFEL & CO., SPRINGFIELD, OHIO U. S. A.

V

Vail, J. H..... 45
Valentine-Clark Co..... 46
Varley Duplex Magnet Co.....
Viaduct Mfg. Co..... 47
Vindex Electric Co..... 42
Vought Berger Co..... 46

W

Waclark Wire Co..... 10
Wagner Electric Mfg. Co.....
Wanted..... 42
Warren Electric Mfg. Co..... 28
Warren Electric & Specialty Co.. 1
Westcott, Geo. F..... 45
Western Electric Co..... 7
Western Electrical Supply Co.....
Western Telephone Mfg. Co..... 47
Westinghouse Electric & Mfg. Co. 51
Weston Electrical Instrument Co.. 30

W

Wheeler Reflector Co..... 18
White & Co., J. G..... 45
Whitney Electrical Inst. Co..... 13
Wilmerding, C. H..... 45
Wyckoff Pipe & Creosoting Co... 30

Z

Zimdars & Hunt.....

(*Continued on page 22.*)

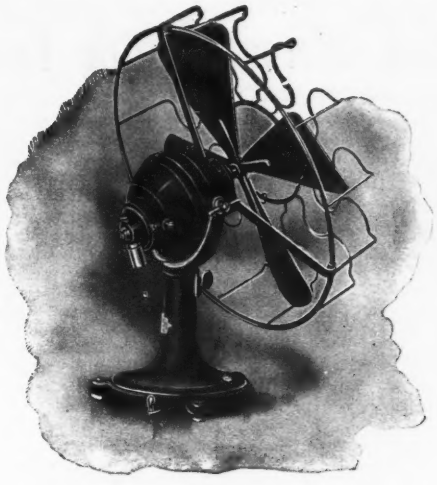
By the Highest Authority

IN the current issue just out of the "American Newspaper Directory," considered the highest and most accurate authority and which bases its circulation ratings on the minimum actual average for fifty-two weeks, the ELECTRICAL REVIEW is rated as having substantiated a circulation of more than 2,000 greater per issue than the rating given any other weekly electrical publication.

To those who know the "low water mark" method and the scrupulous care with which this expert authority makes these ratings, this is significant.

In addition, this Directory gives the ELECTRICAL REVIEW the "Gold Mark," which the index explains as follows: "Advertisers value this paper more for the class and quality of its circulation, than for the mere number of copies printed."

These results have been accomplished through the elaborate personal-call campaign for new subscriptions which has been carried on for two years.



LUNDELL FANS

ARE ACKNOWLEDGED TO BE THE BEST

Dealers desiring quick sales and satisfied customers should handle Lundell Fans. They are universal favorites because of their superior design and construction which give them the highest efficiency, greatest durability, and best commercial value. Orders should be sent in at once to insure prompt delivery. Write for new booklet No. 3076.

Sprague Electric Company

GENERAL OFFICES: 527-531 West 34th Street, New York

BRANCH OFFICES:

CHICAGO: Fisher Building BOSTON: Weld Building ST. LOUIS: Security Building BALTIMORE: Maryland Trust Building

FLOTATION IN AIR

OF THE MOVING PARTS OF STANLEY RECORDING WATTMETERS FOR ALTERNATING CURRENT IS ACCOMPLISHED BY

MAGNETIC SUSPENSION

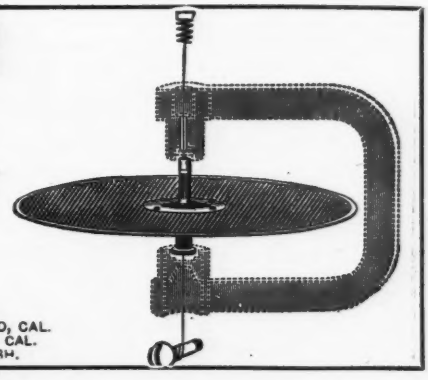
NO WEAR
NO FRICTION

NO LOST REVENUE
ALL CURRENT USED RECORDED

SEND FOR DESCRIPTION AND BOOK FULL OF GOOD INFORMATION
"ABOUT METERS"

STANLEY INSTRUMENT CO.
GREAT BARRINGTON, MASS., U. S. A.

PACIFIC COAST AGENTS
JOHN MARTIN & CO. { SAN FRANCISCO, CAL. / LOS ANGELES, CAL. / SEATTLE, WASH.



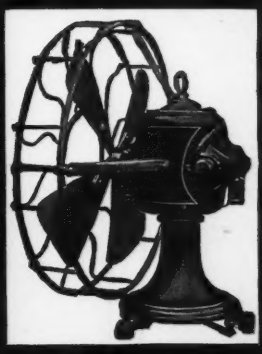
G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I.

G. I. Co.'s

MINIMUM COST OF CURRENT
NO REPAIRS TROUBLE NOISE
MAXIMUM VOLUME OF AIR

MANUFACTURED BY
General Incandescent Arc Light Co.
NEW YORK, N. Y.

PARAGON



TRUNNION

DESK FANS

BRACKET

FANS

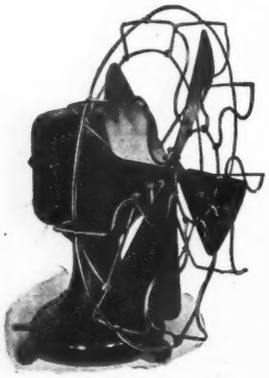
A CHEAP IS THE DEAREST **FAN**

PARAGON FAN AND MOTOR CO.
572-578 First Ave., New York, N. Y.

OFFICES IN EVERY LARGE CITY OF THE U. S.

Diehl Fan Motors
For 1903

NEW DESIGN, HIGH-SPEED CEILING FAN



2 or 3 speeds, with or without lights. We have 12 other designs, any voltage.

Our **New Desk** and **Bracket Fans** are *excellent sellers.* They give *perfect satisfaction* because they are *made right.*

The **Coleman Deflector** is made to install on any make of fan and will operate at any speed or angle. It will diffuse air over nearly ½ of the circle.

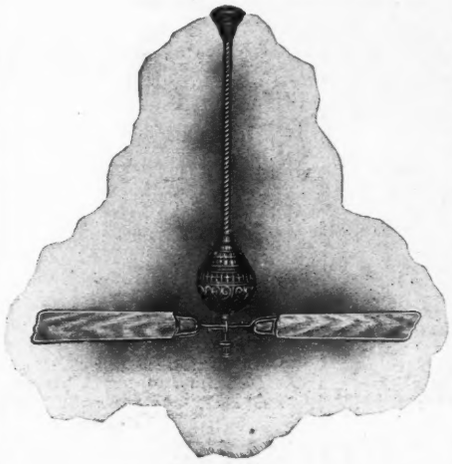
Our new Catalogue gives full description.

Diehl Manufacturing Co.

Main Office and Works, ELIZABETHPORT, N. J.

Branches: NEW YORK, BOSTON, PHILADELPHIA.

Tuerk
Alternating Current Ceiling Fans
1903 MODEL



2-Blade Model

The high standard of excellence possessed by the "Tuerk" Alternating Current Ceiling Fans during the eight years that they have been on the market, will be fully maintained by the 1903 models. They are made with 2 and 4 blades, with and without electrolier attachments.

Spread of blades 60 inches, width 8 inches. Speed 175 R. P. M.; Current consumed, 100 Watts; Cycles, 40 to 140; Voltage, 52 to 230.

Write for catalogue and prices.

HUNTER FAN & MOTOR CO.

Fulton, N. Y., U. S. A.

General and Export Agents: E. B. Latham & Co., 39 Vesey Street New York, U. S. A.

Western Agents: Western Electric Co., Chicago, Ill. Western Electric Co, 810 Spruce Street, St. Louis, Mo.

H. B. COHO & COMPANY, INC.

We carry in stock in New York City a full line of "ECLIPSE" Fan Motors, and power motors for general and special use from ½ to 10 H.-P.

WE SELL GENERATORS AND MOTORS OF ALL SIZES

CATALOGS

114-118 Liberty Street, - - - - NEW YORK

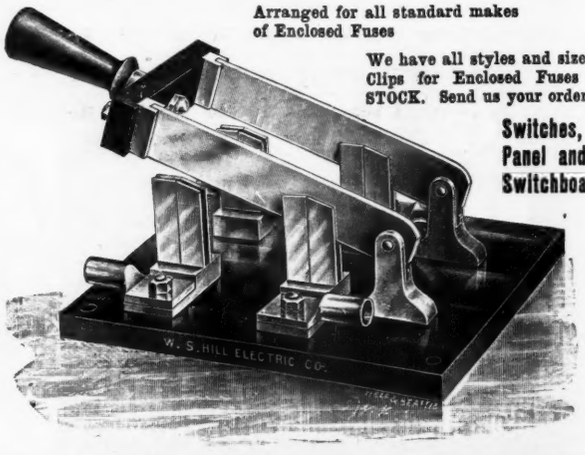
SHELBY LAMPS SHELBY, OHIO.

KNIFE SWITCHES

Arranged for all standard makes of Enclosed Fuses

We have all styles and sizes of Clips for Enclosed Fuses IN STOCK. Send us your order for

Switches, Panel and Switchboards

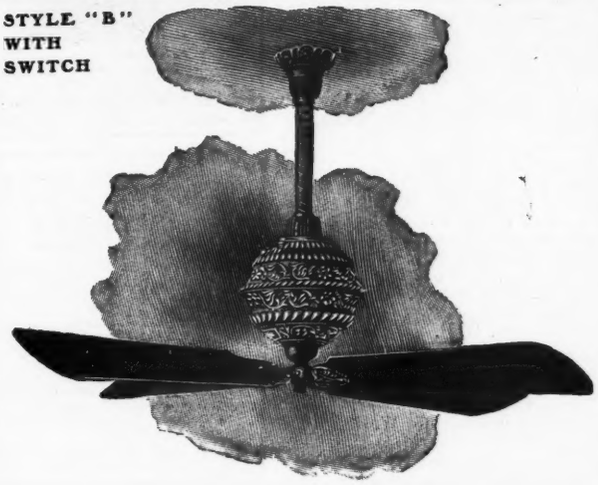


W. S. HILL ELECTRIC COMPANY

NEW BEDFORD, MASS.

THE STANDARD FANS

STYLE "B" WITH SWITCH



THE STORY IN BRIEF

STYLE "A"—Four 25-inch blades, 20 degrees angle, 200 r. p. m., 95 watts at full speed. Finished in three styles.

STYLE "B"—Four 25-inch blades, 20 degrees angle, 200 r. p. m., 110 watts at full speed. Finished in three styles.

500 V. SPECIAL—Four 25-inch blades, 20 degrees angle, 200 r. p. m., 0.2 amp, finished in black enamel with gold lines, and lacquered brass trimmings.

12-INCH DESK OR BRACKET—1,800 r. p. m., 40 watts at full speed.

16-INCH DESK OR BRACKET—1,500 r. p. m., 70 watts at full speed.

Desk and Bracket Fans are adjustable in all directions, and finished in black enamel with gold lines and lacquered brass trimmings.

Circulars Upon Request

The ROBBINS & MYERS COMPANY

Main Offices and Works: SPRINGFIELD, O. New York Office: 170 BROADWAY

The "AXLE LIGHT" System of

Electric Lights and Fans

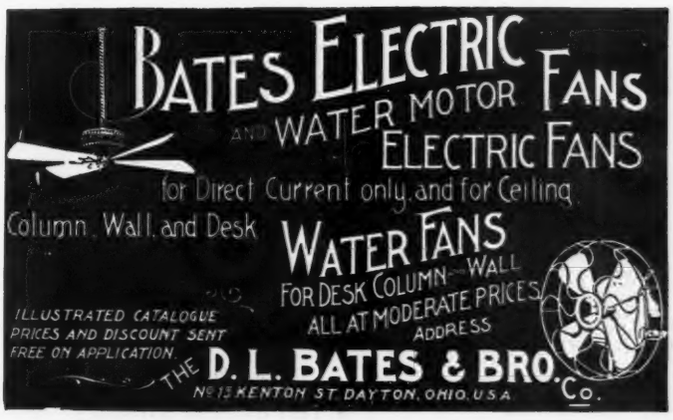
For All Kinds of Passenger Cars

As the "up-to-date method" of car lighting is being used by leading railway lines and is, of course, always preferred by the traveling public.

Consolidated Railway Electric Lighting and Equipment Co.

General Offices, 100 Broadway, New York

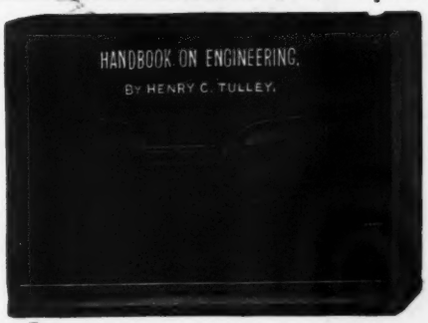
Western Offices, 83 West Jackson Boulevard, Chicago, Ill.



THE BEST AID TO SUCCESS

An Encyclopedia of information, and in itself the most complete Library on Engineering practice ever published for the use of

STEAM USERS, ENGINEERS ELECTRICIANS FIREMEN AND MACHINISTS



This Work Contains

Over 900 pages and 400 fine illustrations. Every branch of Engineering treated in a scientific and comprehensive manner. In it will be found a solution of the many knotty problems met in daily practice.

It is thoroughly reliable and practical; it is not only a guide, but a teacher.

As a reference and text-book it is the fullest, latest and best authority on the subjects treated. It extends to details not found elsewhere.

Indorsed by the foremost practical men in the world.

Handsomely bound in leather and gilt. Pocket-book form.

The 3d edition now ready

Sent anywhere on receipt of price, **$3.50**, money back if not satisfactory.

Send for 48-page illustrated circular

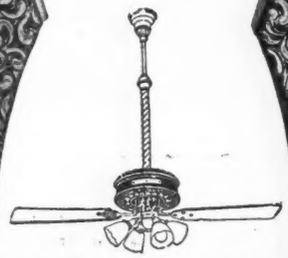
HENRY C. TULLEY & CO., 910 Wainwright Building, ST. LOUIS, MO., U. S. A.

WHOLE-SALE ELECTRICAL SUPPLIES

Emerson Alternating-Current Fans will use less current and give more air than any other make. Lowest Market Price.

"EMERSON" Alternating CEILING DESK and EXHAUST FANS

Send for 1902 Fan Catalogue



DOUBLEDAY-HILL ELECTRIC COMPANY

PITTSBURG PA.

CLASSIFIED INDEX

(Continued from page 17.)

Adjusters, Incandescent Lamps.
Incan. Elec. Light Manipulator Co.
Pacific Electric Co.
Vought-Berger Co.

Air Compressors.
Stilwell-Bierce & Smith-Vaile Co.

Alternators.
Christensen Engineering Co.
Fort Wayne Electric Works.
General Electric Co.
Warren Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.

Armature Repairs.
Cleveland Armature Works.

Batteries, Primary.
American Carbon & Battery Co.
Bunnell & Co., J. H.
Burnley Battery & Mfg. Co.
Edison Mfg Co.
Roche, William.

Batteries, Storage.
American Battery Co.
Electric Storage Battery Co.
Gould Storage Battery Co.
National Battery Co.
Reuterdahl Electric Co.
Smith Storage Battery Co.
United States Battery Co.

Bells.
Ostrander & Co., W. R.

Belt Dressing.
Dixon Crucible Co., Joseph.

Boilers.
Allis-Chalmers Co.
Babcock & Wilcox Co., The.
Stirling Co., The.
Toomey, Frank.

Boiler Cleaners.
Mechanical Boiler Cleaner Co.

Boiler Insurance.
Hartford Steam Boiler Insp. & In. Co.

Books, Technical.
E. L. Powers & Co.
Tulley & Co., Henry C.

Brushes-Dynamo.
Le Valley Vitae Carbon Brush Co.
Speer Carbon Co.

Cable Hangers.
Standard Underground Cable Co.

Cabling Machines.
New England Butt Co.

Carbons.
American Carbon & Battery Co.
Consumers' Carbon Co.
Dickey-Sutton Carbon Co.
General Incandescent Arc Light Co
National Carbon Co.
Speer Carbon Co.

Castings.
Christensen Engineering Co.
New England Butt Co.

Circuit-Breakers.
Cutler-Hammer Mfg. Co.
Cutter Electrical & Mfg. Co.
Fort Wayne Electric Works.
Western Electric Co.

Cleaners, Incandescent Lamps.
Incan. Elec. Light Manipulator Co.

Climbers
Klein & Sons, Mathias.
Smith & Hemenway Co.

Coal Handling Machinery.
C. W. Hunt Co.
The Jeffrey Mfg. Co.

Coal Mining Machinery.
General Electric Co.
The Jeffrey Mfg. Co.

Commutator Lubricant.
Allen & Co., L. B.

Commutator Segments.
Billings & Spencer Co.

Condensers (Electric).
Marshall, Wm.

Conduits.
Alphaduct Mfg. Co.
American Circular Loom Co.
American Conduit Co.
American Vitrified Conduit Co.
Camp Co., H. B.
Field, C. J.
Gest, G. M.
National Conduit & Cable Co.
Osburn Flexible Conduit Co.
Rittenhouse-Miller Co.
Sprague Electric Co.
Standard Vitrified Conduit Co.
Wyckoff Creosoting Co.

Connectors
Smith & Hemenway Co.

Connectors and Terminals.
McIntire Co., The C.

Construction.
J. G. White & Co.
New England Engineering Co

Construction Supplies.
T. H. Brady.

Cross-Arms, Brackets, Pins, Ties, Climbers, Etc.
Central Electric Co.
Donnelly, John.
Fowler, John H.
Klein & Son, Mathias.
Standard Pole & Tie Co.
Valentine-Clark Co.
Wyckoff Pipe & Creosoting Co.

Dynamos and Motors.
Akron Electrical Mfg. Co.
Browning Mfg. Co.
Bullock Electric Mfg. Co.
Central Electric Co.
Coho & Co., H. B.
Christensen Engineering Co.
Cleveland Armature Works.
Crocker-Wheeler Co.
Dustin Co., Chas. E.
Eck Dynamo & Motor Works.
Elwell-Parker Electric Co.
Fort Wayne Electric Works.
General Electric Co.
Gen'l Incandescent Arc Light Co.
Hobart Electric Mfg. Co.
Johnson, Charles F.
Keystone Electric Co.
New England Motor Co.
Robbins & Myers Co.
Rossiter, MacGovern & Co.
Royal Electric Co.
Sprague Electric Co.
Stanley Electric Mfg. Co.
Stow Manufacturing Co.
Thresher Electric Co.
Toomey, Frank.
Wagner Electric Mfg. Co.
Warren Electric Mfg. Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Electric Lighters.
Electric Contract Co.
Stanley & Patterson.

Electric Locomotives.
General Electric Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.

Electrical Instruments.
Bossert Electric Construction Co.
Bullock Electric Mfg. Co.
Bunnell & Co., J. H.
Ericsson Telephone Co.
Fort Wayne Electric Works.
Gen'l Incandescent Arc Light Co.
Lamp Testing Bureau.
Machado & Rollet.
Pignolet, Louis M.
Wagner Electric Mfg. Co.

Electric Soldering Irons.
American Electrical Heater Co.
Simplex Electrical Co.

Electrical Supplies.
Central Electric Co.
Crouse-Hinds Electric Co.
Electric Appliance Co
Ericsson Telephone Co.
Ewing-Merkle Electric Co.
Kinsman Electric & Railway Sup. Co.
Lawrence-Hall Electric Co.
Manhattan Electrical Supply Co.
Marshall-Sanders Co.
Michigan Electric Co
Paiste Co., H. T.
Stanley, Arthur F.
Stanley & Patterson.
Western Electric Co.

Elevating & Conveying Machinery.
Jeffrey Mfg. Co

Electro-Magnets.
Varley Duplex Magnet Co.

Engines (Gas).
Lowell Model Co.

Engines (Steam).
Allis-Chalmers Co.

(Continued on page 45.)

$5 VOLT AMMETER FOR STUDENTS' USE.

(Jewell Bearing and Aluminum Case.) Adapted to primary and storage battery work. List of schools using it mailed on application. The method of its use described in a circular just issued.

L. E. KNOTT APPARATUS CO.,
16 Ashburton Place, - BOSTON, MASS.

ELECTRIC DIALS

The most convenient and reliable method of furnishing uniform time in factories, schools, mills and other large buildings. Readily installed and easily maintained. Also Frying-Pan, Program, Sixty-Day and Calendar Clocks.

Send for Catalogue No. 203.

The Prentiss Clock Improvement Co.
Dept. 20, 49 Dey St., NEW YORK CITY

LEON N. COOPER'S

Rising Sun Carbon Papers and Typewriter Ribbons

NON-SMUT
NON-GREASE

Send for Samples

E. F. P. RAPPEL
5-7 Dey Street, New York

The individuality of

P-K SPECIALTIES

as made by the

H. T. PAISTE CO.

Chicago Philadelphia New York

extends beyond the mere design

This

250 VOLT

ATTACHMENT PLUG

is handsome; but it cannot be short circuited nor broken.

To insure to yourself the best in the market you have only to

Just specify "P-K"

H & H CONDUIT FASTENERS

IS A TIME SAVER
A GREAT CONVENIENCE FOR
CONTRACTORS AND WIREMEN

These fasteners provide a cheap, quick and reliable method of securing flexible Conduits in boxes or wall cases. Made for ⅜-inch or ¼-inch Conduit.

SEND US 10c. FOR 10 SAMPLES BY MAIL.

DIRECTIONS.

Pull the Conduit through outlet, then force the little brass collar over the end. The sharp teeth will readily engage the fabric and hold the Conduit firmly in its place.

THE HART AND HEGEMAN MFG. CO.

92 Union Place, Hartford, Conn.

Underground Transmission without Conduits or Lead Encased Cables.

THE ONLY ABSOLUTELY PERFECT SYSTEM OF ELECTRICAL TRANSMISSION FOR ALL VOLTAGES UP TO 150,000.

Perfect Safety. Low Cost. Permanence. No Expenditure for Maintenance. In Use 5 Years without a Cent for Repairs.
Not Affected by Change of Temperature, or Climatic Conditions.
We Will Execute Contracts of Any Dimensions.
Telephone, Telegraph, Railway or Power.
Write Us Before Concluding Your Plans.

HUNGERFORD ELECTRIC & MANUFACTURING COMPANY

Offices—25 BROAD STREET, NEW YORK **Factories—BELLEVILLE, N. J.**

A Few Don'ts About High-Volt Lamps

Don't use T. H. base on high-volt installations. There will always be more or less trouble with short circuits from inleading wires.

Don't use anything but the Edison screw base.

Don't experiment with new freak types of high-volt lamps. If the maker has not learned, don't help him in his experiments at your own expense.

Don't fail to use great care in wiring all installation work.

Don't fail to use porcelain sockets where possible.

Don't try for too high economy when buying 220 volt lamps.

Don't expect high-volt lamps to furnish you the same useful candle-hours as 100 volt lamps of the same efficiency---they will not do it.

Don't fail to provide for getting rid of static charges.

Don't put in fixtures which require candelabra or any special or small bases.

Don't fuse High-Volt Lamps too heavily. Four will run on a "one-light" fuse.

Don't subject them to great jarring. They are more frail than 100 volt lamps, and if the filaments touch they arc over very readily.

Respectfully,

INDEPENDENT
INCANDESCENT
LAMP CO.

The Chip on his Shoulder.

Independent—
And we are.

The boy tells his own story. We think there is room for one independent maker, who will make lamps, not with the immediate profit alone in view, but with repeat orders as the main vantage point. We want your first order only because we know that will mean your business hereafter. There has been too much short-sightedness, because the average buyer was not equipped to test or measure what he bought. Give us your confidence and we will not betray it.

We have made a fair start in the factory line, and have invested a respectable sum in lamp making only after repeated tests had shown our product was not excelled by any lamp in the market for long life and maintained brilliancy.

Remember we make a complete line of everything and ship no sample, picked lamps. What our first lamps promise our subsequent shipments will do. That is something not carried out everywhere. Try us.

THE INDEPENDENT INCANDESCENT LAMP CO. - CLEVELAND, OHIO. -

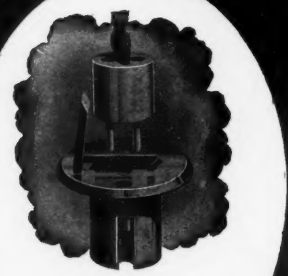
FACTORY: 78 84 SENECA ST.
OFFICE: ROSE BUILDING

Snap Switches
Indicating Switches
Key Switches
Flush Switches
Gang Plates
Push Button Switches
Art Plates
Door Switches
Baby Knife Switches
Punch Clip Knife Switches
Ed., T. H. & West. Key Sockets
Receptacles
Weatherproof Sockets
Attachment Plugs
Midget Plugs & Receptacles
Rosette Plugs & Receptacles
Flush Plugs & Receptacles
K. W. Cut-Outs
Competition Cut-Outs
Branch & Main Cut-Outs
Dow Adjusters
Gongs
Watchman's Registers

THE FAN MOTOR HABIT

can be greatly strengthened and enriched by liberal doses of No. 521 Midget Plug and Receptacle. Fit in the floor, base-board or walls, and on account of their small size and low cost, are exceedingly easy to take.

List $1.00. Case Lots for less money, and a sample for 66 cents, delivered anywhere in the Empire of the UNITED STATES.



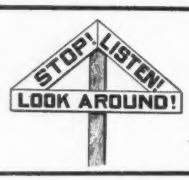
No. 521 Midget Plug and Receptacle.

IF YOU DO NOT RECEIVE OUR REMINDERS, SEND YOUR BUSINESS CARD AND GET THE "CHOICE STUFF" WEEKLY. PLEASE MENTION ELECTRICAL REVIEW.

MARSHALL-SANDERS CO.

BOSTON, MASSACHUSETTS

HART & CO., Monadnock Bldg., Chicago Ill.

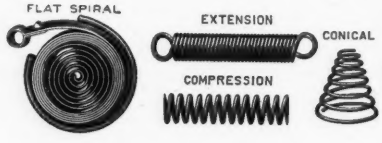


Before Contracting for

INCANDESCENT LAMPS

Get the STERLING SPECIAL Literature.

STERLING ELECTRICAL MFG. CO.
Warren, Ohio.



Cary Spring Works

240 & 242 West 29th St.
NEW YORK CITY

Manufacturers of

Wire and Springs

For Machinery, Motors, Clocks, Music Boxes and all kinds of Electrical Purposes

NOW IS THE TIME

TO SUBSCRIBE FOR

The Inventive Age & Patent Index

ONE DOLLAR A YEAR

Replete with matter pertaining to Patent Office and New Inventions

Contains index of all patents issued

ADDRESS

INVENTIVE AGE PUBLISHING CO.
918 F St., Washington, D. C.

REDUCED RATES TO NEW ORLEANS.

Via Pennsylvania Railroad. Account Meeting American Medical Association.

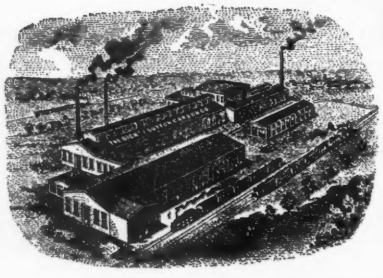
For the benefit of those desiring to attend the meeting of the American Medical Association at New Orleans, La., May 5 to 8, the Pennsylvania Railroad Company will sell excursion tickets from all stations on its lines to New Orleans, on May 1, 2, and 3, good going on those dates and good to return reaching original starting point not later than ten days from date of sale, at *reduced rates*. By depositing ticket with Joint Agent at New Orleans between May 1 and 12, and payment of fifty cents, an extension of final return limit to May 30 may be obtained.

CARBONS

CONSUMERS CARBON CO.

LANCASTER, OHIO, U. S. A.

Carbons of all kinds and for all purposes.



CARBONS

THE DICKEY-SUTTON CARBON COMPANY

LANCASTER, O.

WE MANUFACTURE ELECTRIC LIGHT CARBONS OF ALL KINDS, DRY BATTERIES AND BATTERY CARBONS, CARBON BRUSHES AND SPECIALTIES, ELECTROLYTIC CARBONS

BRYAN-MARSH COMPANY

New York, 136 Liberty St. Chicago, Fisher Building.
Cincinnati, Perin Building. Minneapolis, 1128 Lumber Exchange.
San Francisco, Mills Building.
Factory, Marlboro, Mass.

HEALTH HINTS FOR LAMPS

1. Don't burn a red-hot hair pin.
2. Don't try it, a lamp won't bounce.
3. Don't blame the lamp when the fault lies elsewhere.
4. Don't handle lamps in a basket the way you would potatoes.
5. Don't use transformers with poor regulation, and than blame the lamps.
6. Don't use a special lamp if you can possibly make a standard lamp answer.
7. Don't believe a transformer gives the voltage, the name plate says. Test it.
8. Don't buy foreign fixtures that require special lamps that cannot be purchased in this country.
9. Don't use a wire guard which is supported by the bulb. They are a fruitful cause of breakage.
10. Don't wipe lamps in dry cold weather with a silk cloth. Static charges draw the filament to the side of the bulb.
11. Don't take your men's word for it when they say the lamps are "short-lived." There's a reason for it and nine times out of ten it is not up to the lamp.
12. Don't say its the lamp's fault if excessive blackening occurs in early life. Chemically "exhausted" lamps don't blacken quickly under normal conditions. Look to your regulation or pressure.

Respectfully,

INDEPENDENT INCANDESCENT LAMP COMPANY,

Cleveland, Ohio.

The Chip on his Shoulder

Independent—
And we are

WE INTEND TO SUCCEED BY DESERVING SUCCESS

JUDGING from the support that has been given us consumers are tired of the rash claims of some makers, and appreciate not only our independent position, but our conservative claims, which we can carry out to the letter.

Remember that we can furnish you everything in incandescent lamps, we ship no sample, picked lamps. If our lamps do not suit you, send them back—if they do, they are the kind you can always depend on getting from us.

Our 220-volt lamps in 10, 16 or 32 c. p. will please you as well as our regular line. We know, and we want the chance of proving to you, that we are the people you have been looking for. Just give us the chance. Address,

THE INDEPENDENT INCANDESCENT LAMP COMPANY

CLEVELAND, OHIO.

FACTORY: 78-84 SENECA ST.
OFFICE: ROSE BUILDING

GREAT OAKS FROM LITTLE ACORNS GROW.

WHOLE-SALE ELECTRICAL SUPPLIES

Emerson Alternating-Current Fans will use less current and give more air than any other make. Lowest Market Price.

"EMERSON" Alternating CEILING DESK and EXHAUST FANS

Send for 1902 Fan Catalogue

DOUBLEDAY-HILL ELECTRIC COMPANY

PITTSBURG PA.

CLASSIFIED INDEX

(Continued from page 44.)

Adjusters, Incandescent Lamps.
Incan. Elec. Light Manipulator Co.
Pacific Electric Co.
Vought-Berger Co.

Air Compressors.
Stilwell-Bierce & Smith-Vaile Co.

Alternators.
Christensen Engineering Co.
Fort Wayne Electric Works.
General Electric Co.
Warren Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.

Armature Repairs.
Cleveland Armature Works.

Batteries, Primary.
American Carbon & Battery Co.
Bunnell & Co., J. H.
Burnley Battery & Mfg. Co.
Edison Mfg Co.
Pullen Electric Co., Leon W.
Roche, William.

Batteries, Storage.
American Battery Co.
Electric Storage Battery Co.
Gould Storage Battery Co.
National Battery Co.
Reuterdahl Electric Co.
Smith Storage Battery Co.
United States Battery Co.

Bells.
Ostrander & Co., W. R.

Belt Dressing.
Dixon Crucible Co., Joseph.

Boilers.
Allis-Chalmers Co.
Babcock & Wilcox Co., The.
Stirling Co., The.
Toomey, Frank.

Boiler Cleaners.
Mechanical Boiler Cleaner Co.

Boiler Insurance.
Hartford Steam Boiler Insp. & In. Co.

Books, Technical.
E. L. Powers & Co.
Tulley & Co., Henry C.
Van Nostrand Co., D.

Brushes-Dynamo.
Le Valley Vitae Carbon Brush Co.
Speer Carbon Co.

Cable Hangers.
Standard Underground Cable Co.

Cabling Machines.
New England Butt Co.

Carbons.
American Carbon & Battery Co.
Consumers' Carbon Co.
Dickey-Sutton Carbon Co.
General Incandescent Arc Light Co.
National Carbon Co.
Speer Carbon Co.

Castings.
Christensen Engineering Co.
New England Butt Co.
Phosphor-Bronze Smelting Co., Ltd.

Circuit-Breakers.
Cutler-Hammer Mfg. Co.
Cutter Electrical & Mfg. Co.
Fort Wayne Electric Works.
Western Electric Co.

Cleaners, Incandescent Lamps.
Incan. Elec. Light Manipulator Co.

Climbers
Klein & Sons, Mathias.
Smith & Hemenway Co.

Coal Handling Machinery.
C. W. Hunt Co.
The Jeffrey Mfg. Co.

Coal Mining Machinery.
General Electric Co.
The Jeffrey Mfg. Co.

Commutator Lubricant.
Allen & Co., L. B.

Commutator Segments.
Billings & Spencer Co.

Condensers (Electric).
Marshall, Wm.

Conduits.
Alphaduct Mfg. Co.
American Circular Loom Co.
American Conduit Co.
American Vitrified Conduit Co.
Camp Co., H. B.
Field, C. J.
Gest, G. M.
National Conduit & Cable Co.

Conduits.
Osburn Flexible Conduit Co.
Rittenhouse-Miller Co.
Sprague Electric Co.
Standard Vitrified Conduit Co.
Wyckoff Creosoting Co.

Conduit Benders.
Benson & Co., Wm. W.

Connectors
Smith & Hemenway Co.

Connectors and Terminals.
McIntire Co., The C.

Construction.
J. G. White & Co.
New England Engineering Co

Construction Supplies.
T. H. Brady.

Cross-Arms, Brackets, Pins, Ties, Climbers, Etc.
Central Electric Co.
Donnelly, John.
Fowler, John H.
Klein & Son, Mathias.
Standard Pole & Tie Co.
Valentine-Clark Co.
Wyckoff Pipe & Creosoting Co.

Dynamos and Motors.
Akron Electrical Mfg. Co.
Browning Mfg. Co.
Bullock Electric Mfg. Co.
Central Electric Co.
Coho & Co., H. B.
Christensen Engineering Co.
Cleveland Armature Works.
Crocker-Wheeler Co.
Dustin Co., Chas. E.
Eck Dynamo & Motor Works.
Elwell-Parker Electric Co.
Fort Wayne Electric Works.
General Electric Co.
Gen'l Incandescent Arc Light Co.
Hobart Electric Mfg. Co.
Johnson, Charles F.
Keystone Electric Co.
New England Motor Co.
Robbins & Myers Co.
Rossiter, MacGovern & Co.
Royal Electric Co.
Sprague Electric Co.
Stanley Electric Mfg. Co.
Stow Manufacturing Co.
Thresher Electric Co.
Toomey, Frank.
Wagner Electric Mfg. Co.
Warren Electric Mfg. Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Electric Lighters.
Electric Contract Co.
Stanley & Patterson.

Electric Locomotives.
General Electric Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.

Electrical Instruments.
Bossert Electric Construction Co.
Bullock Electric Mfg. Co.
Bunnell & Co., J. H.
Ericsson Telephone Co.
Fort Wayne Electric Works.
Gen'l Incandescent Arc Light Co.
Lamp Testing Bureau.
Machado & Roller.
Pignolet, Louis M.
Wagner Electric Mfg. Co.

Electric Soldering Irons.
American Electrical Heater Co.
Simplex Electrical Co.

Electrical Supplies.
Central Electric Co.
Crouse-Hinds Electric Co.
Electric Appliance Co
Ericsson Telephone Co.
Ewing-Merkle Electric Co.
Jones & Son, J.
Kinsman Electric & Railway Sup. Co.
Lawrence-Hall Electric Co.
Manhattan Electrical Supply Co.
Marshall-Sanders Co.
Michigan Electric Co
Paiste Co., H. T.
Stanley, Arthur F.
Stanley & Patterson.
Western Electric Co.

Elevating & Conveying Machinery.
Jeffrey Mfg. Co

(Continued on page 67.)

Just specify **"P-K"**

250 VOLT

ATTACHMENT PLUG.

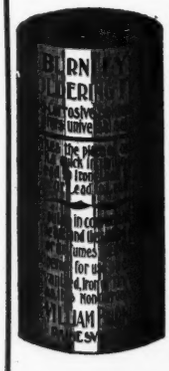
The "P-K"

is the Attachment Plug that can neither be broken nor short-circuited. It is the handy and handsome one.

H. T. PAISTE CO.

Chicago, New York, Phila.

Ask for our new catalogue No. 10.



QUICK AND GOOD WORK is the kind that

BURNLEY SOLDERING PASTE (Patented)

will help you to do. Put up in 2 oz., 4 oz., ½ lb., 1 lb., 5 lb., 10 lb. and 50 lb. packages.

Stick and Paste

The Burnley Battery and M'f'g Co.

Palnesville, Ohio

DRY BATTERIES

TRANSFORMERS

For light and power service. Any voltage. Any size.

A special transformer for multiple arc street service.

Alternating current enclosed arcs, operated in multiple, is the most satisfactory street system in use to-day.

VINDEX ELECTRIC CO.

Factory, Aurora, Ill. CHICAGO, ILL.

ELECTRIC DIALS

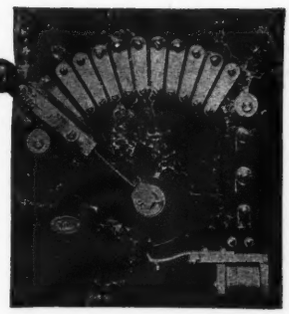
The most convenient and reliable method of furnishing uniform time in factories, schools, mills and other large buildings. Readily installed and easily maintained. Also Frying-Pan, Program, Sixty-Day and Calendar Clocks.

Send for Catalogue No. 203.

The Prentiss Clock Improvement Co.

Dept. 20, 49 Dey St., NEW YORK CITY

C & H



MOTOR-SPEED REGULATORS
WITH
AUTOMATIC RELEASE

ANY H. P. ANY VOLTAGE

The Cutler-Hammer Mfg. Co.
Milwaukee, Wis.

Chicago 1232 Monadnock Bldg. | New York 136 Liberty St. | Pittsburg 319 Frick Bldg.

ANYTHING IN REFLECTORS

If you don't find what you require listed in our Catalogue, send us your specifications and we can make it.

We are the Largest Manufacturers

WHEELER REFLECTOR CO.

156 PEARL STREET, BOSTON
Foreign Department, 88 Maiden Lane, New York City

PLATINUM

IN SHEET OR WIRE FOR ALL PURPOSES

SCRAP PURCHASED.

AMERICAN PLATINUM WORKS,
Formerly CHARLES F. CROSELMIRE. 251 to 255 New Jersey R. R. Ave. NEWARK, N. J.

--JEWELL-- INSTRUMENTS

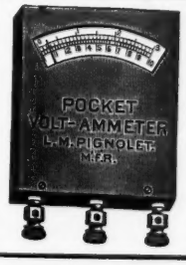
FOR DIRECT CURRENT ONLY ARE USED BY DISCRIMINATING ENGINEERS . . . . .

These Shunts are made with zero temperature coefficient of unchanging material, and are both electrically and mechanically satisfactory

JEWELL ELECTRICAL INSTRUMENT COMPANY

61 & 63 Union Park Court, cor. Carroll Ave., Chicago, Ill., U. S. A. 4

THE PHOSPHOR BRONZE SMELTING CO. LIMITED,
2200 WASHINGTON AVE., PHILADELPHIA.
"ELEPHANT BRAND PHOSPHOR-BRONZE"
INGOTS, CASTINGS, WIRE, RODS, SHEETS, ETC.
— DELTA METAL —
CASTINGS, STAMPINGS AND FORGINGS.
ORIGINAL AND SOLE MAKERS IN THE U.S.



Voltmeters, Ammeters, and Volt-Ammeters . . .

POCKET SIZE,
VARIOUS RANGES.
ACCURATE,
RELIABLE.

For General Measurements, Testing Storage and Primary Batteries, Circuits, Etc.

L. M. PIGNOLET,
Manufacturer of ELECTRIC INSTRUMENTS, and ELECTROTHERAPEUTIC APPARATUS.
78 Cortlandt Street, New York.

The Whitney Testing Set

here illustrated contains one of the most sensitive D'Arsonval galvanometers made and its resistance coils are guaranteed adjusted to ½ of 1 per cent. The range is 0.01 ohm to 5 megohms.

Write for details and discounts.

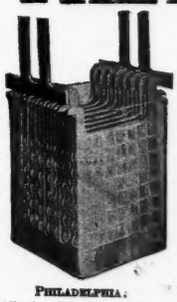
Machado & Roller
203 Broadway, New York, N. Y.
General Agents of Whitney Electrical Inst. Co.

LIST PRICE, $38.00

THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA

MANUFACTURER OF THE



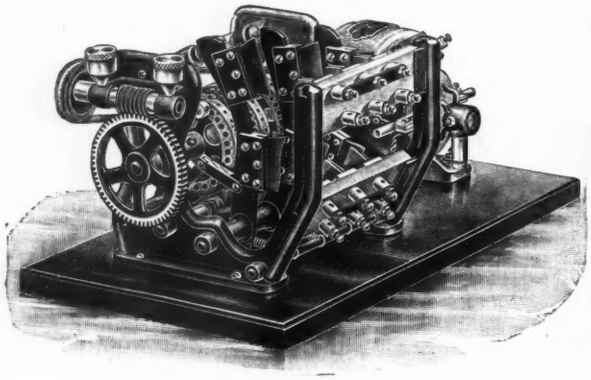
"Chloride Accumulator"

For Central Stations, Electric Railways, Isolated Lighting and Power Stations, Fire Alarm, Telegraph, Train Lighting, etc., etc.

PRICE LISTS AND DESCRIPTIVE BULLETINS FORWARDED UPON REQUEST

— SALES OFFICES —

PHILADELPHIA: Allegheny Ave. & 19th St. | NEW YORK: 100 Broadway | BOSTON: 60 State Street | CHICAGO: Marquette Bldg. | BALTIMORE: Continental Trust Bldg. | ST. LOUIS: Wainwright Bldg. | SAN FRANCISCO: Nevada Block | CLEVELAND: Citizens Bld'g | HAVANA CUBA: G. F. Greenwood, Manager 34 Empedrado Street



WRITE FOR

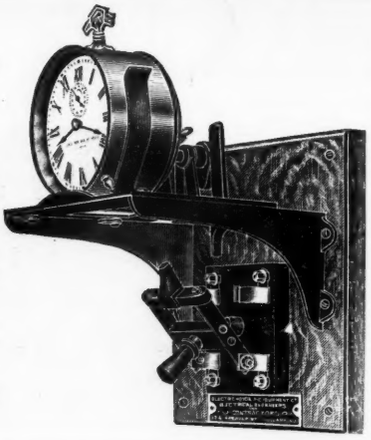
Bulletins on our Flashes and Time Switches

ELECTRIC SIGNS

Our signs bear the stamp of originality

The Electric Motor and Equipment Co.

Newark, N. J.



Adjustable While Running to Tighten Belt.

Patented June 28, 1898.

Supply Dealers

J. Frank Eline & Co., Md. Elect. Supply Co., Jos. M. Zamoiski, Viaduct Mfg Co., etc.,

of Baltimore, say we make the best Water Motors and Fans.

Never Leak!

Agents wanted for the **"POLAR"**

TRADE MARK.

Universal Water Fan and Water Motor

Water Motors ⅛ to 10 H. P

THE ONLY **Water Fan**

Adjustable in every Direction While Running

Never out of order. Ball and Socket Patented. Beware of Infringements. Size of Fan, 12 in. diameter.

Good Side Line for Salesmen

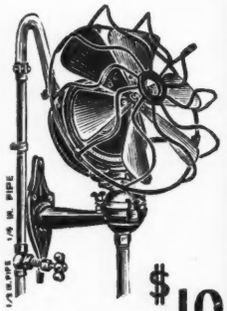
A. Rosenberg Co.

Dep't A—629

Baltimore, Md., U. S. A.

Will outwear 10 ElectricFans

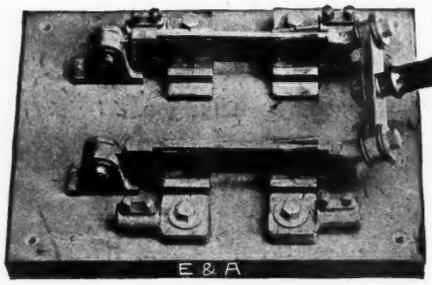
Big Discount to Dealers.



Bracket Style, complete, **$19.**

GEORGE T. EYANSON & CO.

15 N. Seventh Street, Philadelphia, Pa.



Manufacturer of

HIGH GRADE SWITCHES SWITCHBOARDS and PANEL BOARDS

FOR ALL USES

New York Representative, J. GOODMAN & CO., 23 Duane Street

THE HUBBELL UNIVERSAL ATTACHMENT PLUG

BASE SCREWS IN
CAP SNAPS ON

NO TWISTING OF THE WIRE

LATEST SIMPLEST BEST

HARVEY HUBBELL

Main Office and Factory

New York BRIDGEPORT, CONN. Chicago

Packard

Lamps and Transformers

New York & Ohio Company
402 North Ave., Warren, Ohio
New York Office: 1 Broadway

THE SCHWERDTLE STAMP CO.

STENCILS-BURNING BRANDS
STEEL STAMPS & DIES
SEALS-MACH. PLATES-CHECKS

BRIDGEPORT, CONN.

ELECTRICAL TESTING

We are now prepared to undertake Electrical Testing of all kinds. Electrical and Photometrical Standardizations, Tests of Lamps, Instruments, Materials and Supplies. Secondary Standards of Candle-Power furnished. LAMP TESTING BUREAU, 14 Jay St., New York. Tel. 3388 Franklin.

WHEN ADDRESSING ADVERTISERS PLEASE MENTION THIS PAPER.

McINTIRE'S PATENT

Connectors and Terminals.

Special Connectors for HARD-DRAWN COPPER WIRE, all sizes. FUSED WIRE. FUSED LINKS and STRIPS.

THE C. McINTIRE CO.,

13 & 15 Franklin St., Newark, N. J.

ENCLOSED ARC LAMPS

For All Circuits

THE OSBORN-MORGAN CO.

Cleveland, Ohio

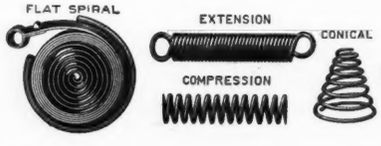
Cary Spring Works

240 & 242 West 29th St.
NEW YORK CITY

Manufacturers of

Wire and Springs

For Machinery, Motors, Clocks, Music Boxes and all kinds of Electrical Purposes



MAGNETIC SUSPENSION

STANLEY RECORDING WATTMETERS.

NO WEAR
NO FRICTION.

NO REVENUE LOST.
ALL CURRENT USED RECORDED.

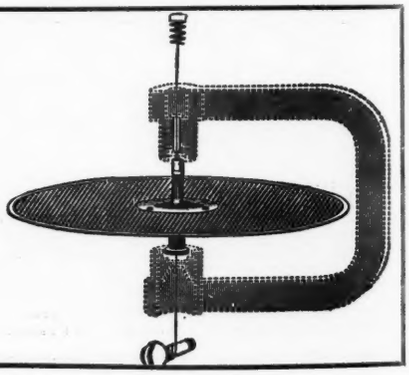
Send for description and book full of good information

"ABOUT METERS."

STANLEY INSTRUMENT CO., Great Barrington, Mass., U. S. A.

EUROPEAN OFFICE, 23 Boulevard des Italiens, Paris, France.

SALES AGENTS
FOR PACIFIC COAST—JNO. MARTIN & CO., San Francisco, Cal., Los Angeles, Cal., and Seattle, Wash.
FOR COLORADO, IDAHO, MONTANA, NEW MEXICO and WYOMING—THE HENDRIE & BOLTHOFF M'F'G & SUPPLY CO., Denver, Col.
FOR MEXICO—VICTOR M. BRASCHI & BRO., Mexico City



INFRINGEMENT

Notice is hereby given that this company owns U. S. Patents issued May 10, 1898, October 17, 1899, October 24, 1899 and January 1st, 1901.

These patents together with others now pending and shortly to be issued cover all practical forms of baby filament turn-down lamps constructed to fit the three standard types of sockets in general use. Dealers and users of electrical apparatus are therefore notified that they become liable to us in the making or selling or using of any form of turn-down lamp employing a baby filament, and infringing the above patents.

THE PHELPS COMPANY, Detroit, U. S. A.

The dealer in electric lamps will get more net money and less net "trouble" from imperfect lamps thrown back on his hands if he sells the original genuine

HYLO

"The Nation's pleasure ground and sanitarium."

THE ADIRONDACK MOUNTAINS

The lakes and streams in the Adirondack Mountains are full of fish; the woods are inviting, the air is filled with health, and the nights are cool and restful. If you visit this region once, you will go there again. An answer to almost any question in regard to the Adirondacks will be found in No. 20 of the "Four-Track Series," "The Adirondacks and How to Reach Them;" issued by the

NEW YORK CENTRAL

A copy will be mailed free on receipt of a two-cent stamp by George H. Daniels, General Passenger Agent, Grand Central Station, New York.

IF YOUR COPY IS RIGHT AND YOUR CUTS ARE GOOD

and your market is within the electrical and mechanical industries of the United States and foreign countries, you will get value from your advertising if in the NATIONAL ELECTRIC LIGHT CONVENTION NUMBER, May 23, 1903. Send copy instructions to either office—13 Park Row, New York, or 40 Dearborn Street, Chicago; 42 Old Broad Street, London, E. C.

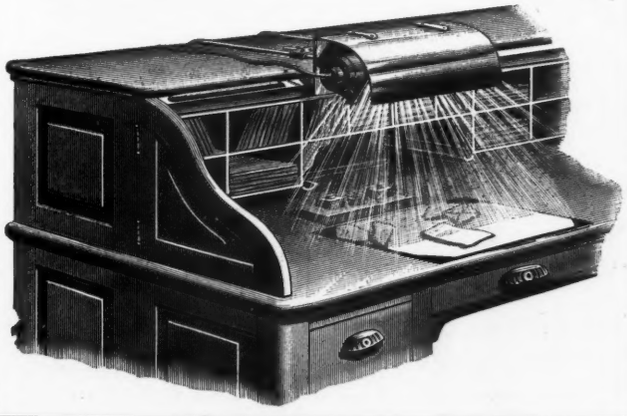
MORSE TWIST DRILL AND MACHINE CO.

New Bedford, Mass., U. S. A.

No. 112 DRILLS FITTING SILVER & DEMING'S AND PRENTICE BLACKSMITHS' DRILL PRESSES NOS. 1 AND 2, WITH SHANKS ½ INCH DIAMETER. SHORT LENGTHS.

Drills larger than ½ inch, with Shanks ½ inch diameter and Drills with Shanks .647 inch diameter, fitting Silver & Deming's Press Nos. 3 and 4, same price as No. 110 for Coe's Drill Press. All Drills $\frac{7}{8}$ inch and larger are 6 inches entire length. Shanks for No. 112 Drills 2½ inches long.

(1)



Kinsman Daylight Desk Lamp

If the advantages of the Daylight Desk Lamp are not clear to you from the cut, the light from one will show that there is no other desk lamp on the market that can compare with it for lighting up the whole desk interior. Unusually large range of adjustability. A nickel-plated beauty and a winner.

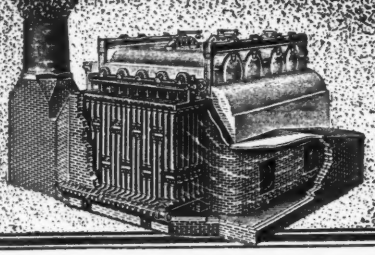
PRICE, $2.00

Kinsman Electric and Railway Supply Company

91 Liberty Street, New York

GREEN'S ECONOMIZER

SAVES 10 TO 20% IN FUEL



An item worth considering at the present price of coal

Special designs for ELECTRIC LIGHT and POWER PLANTS

See our free booklet "Green's Economizer" for detailed information

THE GREEN FUEL ECONOMIZER COMPANY

MATTEAWAN, N. Y.

Sole manufacturers in the U. S. A.

ALPHABETICAL INDEX.—*(Continued from page 36.)*

M

Machado & Roller..... 37
Magnet Wire Co..... 1
Manhattan Electrical Supply Co.. 64
Marshall, Wm..... 62
Marshall-Sanders Co..... 20
Massachusetts Chemical Co..... 9
McGill University..... 40
McIntire Co., The C..... 38
McTighe, Thos. J..... 67
Mead Cycle Co..... 65
Mechanical Boiler Cleaner Co..... 25
Menchen, Joseph P..... 50
Mica Insulator Co..... 40
Michigan College of Mines..... 64
Michigan Electric Co..... 20
Monarch Fire Appliance Co..... 1
Montauk Fire-Detecting Wire Co. 39
Morse Twist Drill Co..... 63
Munsell & Co., Eugene..... 26
Murdock, H. D..... 6
Murdock Parlor Grate Co.....

N

National Battery Co.....
National Carbon Co.....
National Conduit & Cable Co..... 1
National India Rubber Co..... 1
Nernst Lamp Co..... 74
New England Butt Co..... 10
New England Engineering Co.... 8,67
New England Motor Co..... 26
New York & Ohio Co..... 38
New York Cen. & Hudson Riv. R. R. 39,41
New York Insulated Wire Co.... 1
New York Telephone Co..... 68
New Process Raw Hide Co..... 65
North Electric Co..... 70

O

Okonite Co..... 1,11
Osborn-Morgan Co..... 38
Osburn Flexible Conduit Co..... 1
Ostrander, W. R. & Co..... 69
Otis Elevator Co..... 34

P

Pacific Electric Co..... 20
Pairpoint Corporation..... 6
Paiste Co., H. T..... 48
Parsell & Weed..... 64
Peerless Electric Company..... 12,13
Pennsylvania R. R..... 42,69
Phelan, D. W..... 68
Phœnix Glass Co..... 1
Phelps Co..... 61
Phillips, Eugene F., Bare and Insulated Wires..... 1
Phillips Insulated Wire Co..... 76
Phosphor-Bronze Smelting Co.... 37
Pignolet, Louis M..... 37
Portland Co., The .....
Power Installation Co..... 67
Powers Co., The E. L..... 67
Prentiss Clock Improvement Co... 48
Proposals..... 64
Pullen Electric Co., Leon W..... 40

R

Rae, Frank B..... 67
Rappel, E. F. P..... 64
Reuterdahl, Arvid..... 67
Reuterdahl Electric Co..... 6
Risdon-Alcott Turbine Co..... 44
Rittenhouse-Miller Co..... 21
Robbins & Myers Co..... 15
Robe Fibre Pulley Covering Co.. 40
Robertson & Sons, Jas. L..... 64
Roebling's Sons Co., John A..... 76
Rooney-Westbury Elec. Lamp Co. 50,62
Rosenberg Co., E..... 38
Rossiter, MacGovern & Co..... 63
Runyon, F. O..... 67
Russell Tomlinson Elec Co..... 70

S

Safety Insulated Wire & Cable Co.. 10
Samson Cordage Works..... 61
Schapirograph Co..... 64
Schwerdtle Stamp Co..... 38
Shelby Electric Co..... 21,64
Siggers & Siggers..... 61
Sills-Eddy Mica Co..... 6
Simplex Electrical Co..... 1
Simplex Electric Heating Co..... 40
Smith Storage Battery Co..... 6
Smith & Hemenway Co..... 76
Speer Carbon Co..... 76
Sprague Electric Co..... 15,50

(Continued on page 44.)

PULLEN CELLS

for operating

BATTERY FANS

2 volts each Cell

LONG LIFE

SEND FOR CIRCULAR AND PRICES

LEON W. PULLEN ELEC. COMPANY

16 Chestnut Street, Philadelphia

CUT OUT THE BELT SLIP

USE ROPE FIBRE PULLEY COVERING

Good on any kind of pulley, wood or iron, old or new. No Preparation, special tools—put on by hand in a few minutes.

EFFECTIVE AT ONCE

ROPE FIBRE PULLEY COVERING CO. Springfield, OHIO

WHEN ADDRESSING ADVERTISERS PLEASE MENTION THIS PAPER.

STUART-HOWLAND CO.

Largest Line of RAILWAY, TELEPHONE and LIGHTING SUPPLIES in New England

4-5 WINTROP SQUARE and 261-287 DEVONSHIRE ST.

BOSTON

MICHIGAN COLLEGE OF MINES

F. W. McNAIR, President.

Regular summer term opens June 8 For Year Book giving list of graduates and their occupations, apply to President or Secretary, Houghton, Michigan.

McGILL UNIVERSITY MONTREAL CANADA

Courses in Architecture, Civil Engineering, Mechanical Engineering, Electrical Engineering, Mining Engineering, Practical Chemistry.

For descriptive pamphlet or information, address

J. A. NICHOLSON, Registrar

HENRY T. BOVEY, Dean

University of Wisconsin MADISON WIS.

College of Mechanics and Engineering

Courses in Civil, Sanitary, Mechanical, Electrical and Electro-Chemical Engineering. All professional instruction given by men of large practical experience in their respective departments. Completely equipped shops and laboratories. Graduate students received in all courses. Gymnasium, boating facilities and athletic opportunities unexcelled. Fees moderate. "Madison has the most magnificent site of any inland town of America." It is as healthful as it is beautiful. For catalogue or information, address

J. B. JOHNSON, Dean, Madison, Wis.

ELECTRIC HEATING APPARATUS

OF EVERY DESCRIPTION

"Unit" Enamel Rheostats

The Simplex Electric Heating Co.

CAMBRIDGEPORT MASS.

INCANDESCENT LAMP REPLACER and CLEANER

HANDLES THEM AT ANY HEIGHT OR ANGLE

Incandescent Electric Light Manipulator Co.

116 Bedford St., Boston, Mass.

EXPOSITION FLYER

VIA

"BIG FOUR"

FROM

CINCINNATI

TO

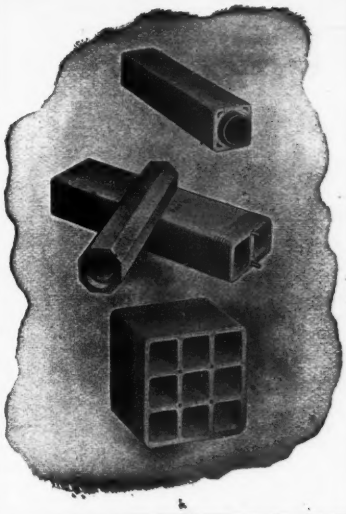
ST. LOUIS

WRITE FOR RATES AND FOLDERS

WARREN J. LYNCH, Gen'l Pass. & Tkt. Agt.

W. P. DEPPE, Asst. Gen'l P. & T. A.

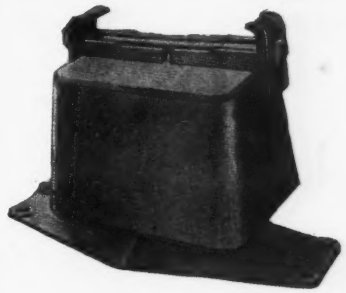
CINCINNATI, OHIO



American Vitrified Conduit Co.

GENERAL OFFICE — Broadway-Maiden Lane Building, NEW YORK

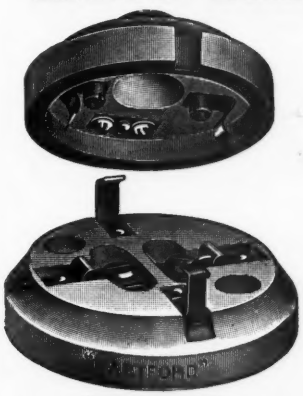
Manufacturers of **VITRIFIED GLAZED CONDUIT**



MANHATTAN THIRD-RAIL INSULATOR

40,000 of this type Insulator furnished by us to Manhattan Railway Co. of New York

"HARTFORD" ROSETTES



FOR CLEAT, CONCEALED AND MOULDING WORK.

Approved by the UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION.

Cap and bases interchangeable.

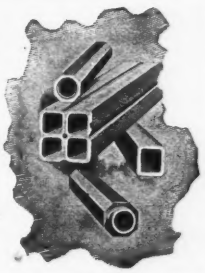
Positive lock and sure contact.

Cap can not be loosened or contact lessened by shaking or pulling on the cord.

"CONCEALED."

THE **HART MFG. CO.,** HARTFORD, CONN.....

Vitrified Clay Conduits



MULTIPLE
SINGLE

LARGE FACTORIES, MODERATE PRICES
PROMPT DELIVERIES

Sole Sales Agent for Factories. Expert Engineers. Contracts for Conduits or Complete Subway Systems. The largest and most difficult contracts undertaken.

C. J. FIELD
Field Conduit Contracting Co.
29 Broadway, New York

Look for this Trademark

On Flexible Conduits

IT SIGNIFIES QUALITY
— The —
Rittenhouse-Miller Co.
923 Witherspoon Bldg.
Philadelphia

ELECTRIC LAUNCHES

A PAYING INVESTMENT AT PARKS AND PLEASURE RESORTS

Can't Explode

SIMPLE IN CARE RELIABLE IN OPERATION

No Heat - No Smoke - No Smell

THE ELECTRIC LAUNCH COMPANY
Avenue A and North Street
BAYONNE CITY, N. J.

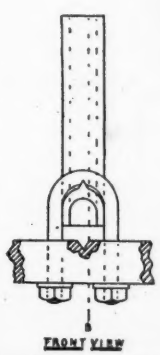
THE BRADY MAST ARMS

T. H. BRADY, New Britain, Conn., U. S. A.
MANUFACTURER OF

Mast Arms, Pole and Swinging Hoods, House Brackets and other specialties for construction work

Catalogue and Prices Furnished on Application

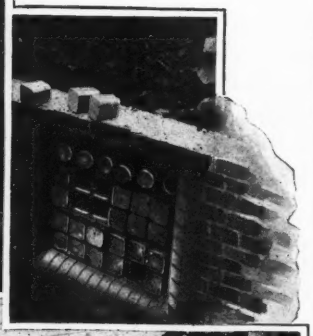
SHELBY LAMPS SHELBY, OHIO.

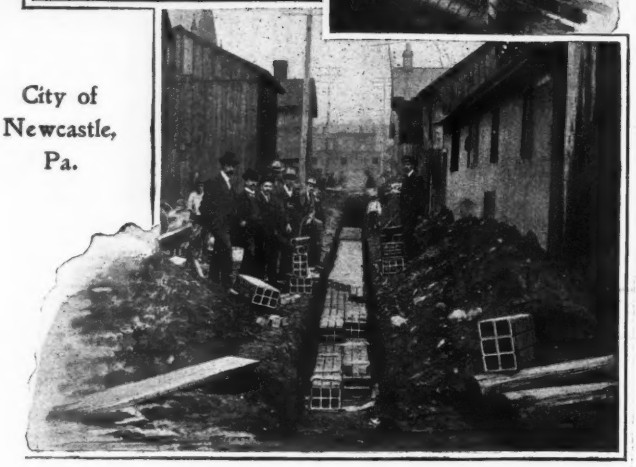


A one-half inch Conduit Bender for Three Dollars net. Weight Five Pounds. Our Five Size Conduit Bender used by the U. S. Govt. and the Leading Contractors of the U. S. List $30.00. Thirty Days Trial Free.

TWO U. S. PATENTS

WILLIAM W. BENSON & CO., 1011 Chestnut St., Philadelphia, Pa.





City of Newcastle, Pa.

CONSTRUCTION DIFFICULTIES

are ameliorated by the use of the single and multiple duct made by the Standard Vitrified Conduit Company

Extensive Subway Systems

may be undertaken with the assurance that material will be forthcoming promptly

Exacting Specifications

may be rigidly met, and RUSH propositions made easy, due to

Regularity of Processing
High Grade Stoneware Clay
Modern Factory Utilities
Experienced Workmanship

Standard Vitrified Conduit Company

Underground Conduits, Insulators, and Special Clay Products.
39-41 Cortlandt Street, New York City.

R. W. LYLE, President and General Manager.
B. S. BARNARD, Vice-President and Secretary

ON THE PACIFIC COAST . . .

"I saw three copies of the **ELECTRICAL REVIEW**," said a salesman who calls on the electric lighting industry, "to one of any other electrical journal. Our advertisement in the **ELECTRICAL REVIEW** aided me in my work as they knew us through it before I called on them."

OPPORTUNITY!!

If you don't know where to get it—
"Look it up in the Green Book"

For the asking!!

EWING-MERKLE ELECTRIC CO.

SAINT LOUIS

No matter how good your overhead lines are they should go underground. Economy and decreased cost of operation.

I design and construct conduit systems for all purposes.

G. M. GEST

Broadway Chambers Building,
277 BROADWAY, NEW YORK.

Union Trust Building,
CINCINNATI, OHIO.

American Conduit Co.

Manufacturers of

Bituminized Fiber Conduit (Patented)

For UNDERGROUND ELECTRICAL WORK

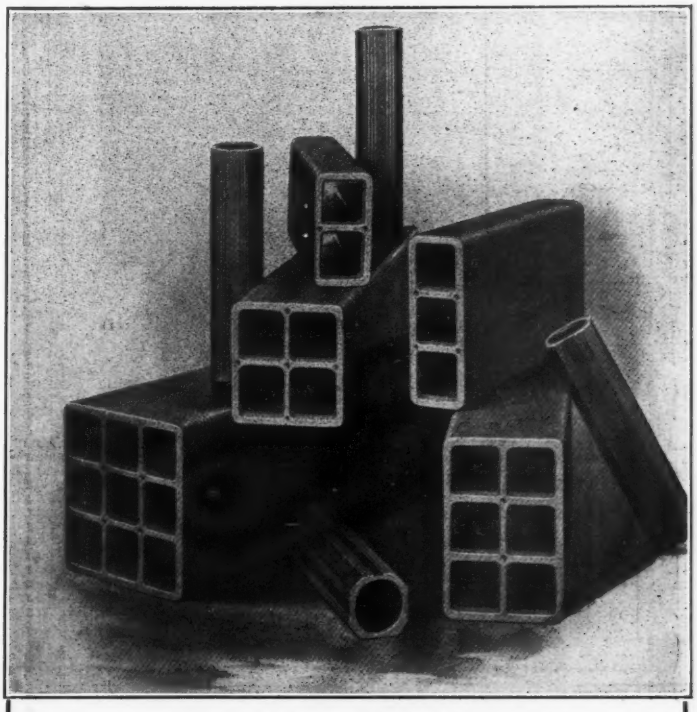
Our Conduit is ELECTROLYSIS-PROOF, NON-ABRASIVE, MOISTURE-PROOF, NON-CORROSIVE, CHEAPLY and RAPIDLY LAID

Insulation Test 66,000 Volts

We give you a perfect joint, which is self-aligning and makes each duct a continuous tube from manhole to manhole.

It will pay all those interested in subway construction to write us for particulars and prices before closing contracts for Conduit. State sizes and quantity desired.

Offices: 720 Arcade Building, PHILADELPHIA, PA.
822 Manhattan Building, CHICAGO, ILL.
336 Macy St., LOS ANGELES, CAL.
Factories: Chester, Pa., Chicago, Ill., Los Angeles, Cal.



THE H. B. CAMP CO.

170 Broadway, New York 85 Hartford Bldg., Chicago

LARGEST MANUFACTURERS OF

VITRIFIED CLAY CONDUIT

FOR ELECTRIC WIRES

Third Edition Revised

Pocket Size, Flexible Leather, 1,000 Pages, with innumerable Diagrams, Illustrations and Tables. Price, $5.00.

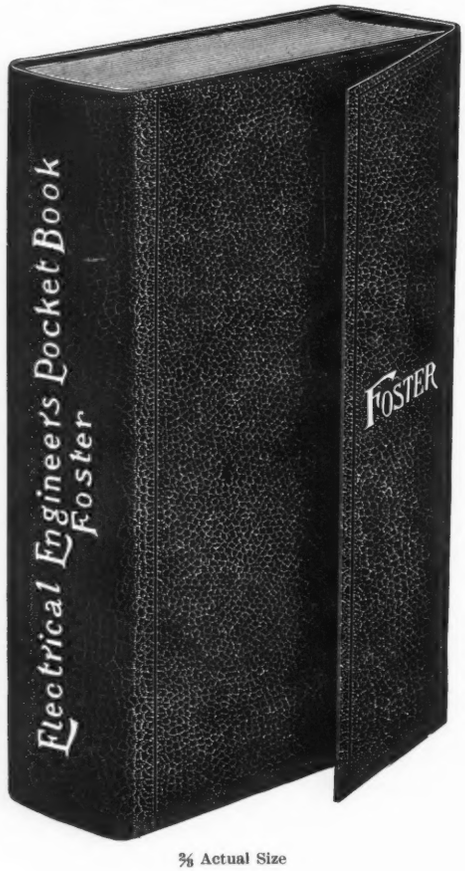
Electrical Engineer's Pocketbook

The most complete book of its kind ever published, treating of the latest and best practice in Electrical Engineering.

By HORATIO A. FOSTER

Member Amer. Inst. E. E., Member Amer. Soc. M. E.

(With the Collaboration of Eminent Specialists)



⅜ Actual Size

CONTENTS

Electrical Engineering Symbols. Electrical Engineering Units. Description of Instruments. Resistance Measurements. Measurement of E. M. F. Measurement of Capacity. Measurement of Inductance. Measurement of Power on Alternating Current Circuits. Tests with Voltmeter. Determination of Magnetic Properties of Iron and Steel. Determination of Wave Form of E. M. F. and Current. Conductors, Properties of. Conductors, Relation and Dimensions of, for Transmission of Electric Current. Transmission of Power. Switchboards and Switching Devices. Cable Testing. Electromagnets. Dynamos. Motors. Testing Dynamos and Motors. Static Transformers. Electric Lighting. Electric Railways. Storage Batteries. Telegraph. Telephone. Electro-Chemistry. Electro-Metallurgy. Electric Heating, Welding and Cooking. Electricity Meters. Lighting Arresters. Lightning Conductors. National Code Rules and Requirements. Miscellaneous Electrical Data. Certain Uses of Electricity in U. S. Army and Navy. Mechanical Section. Index.

Just Published

8vo, Cloth, 259 Pages, Illustrated. Price, $2.50 net

(Binding, Uniform with author's "Dynamo Electric Machinery.")

Alternating Current Machines

Being the Second Volume of

Dynamo Electric Machinery;

Its Construction, Design and Operation

By

Samuel Sheldon, A. M., Ph. D.

Professor of Physics and Electrical Engineering at the Polytechnic Institute of Brooklyn

And

Hobart Mason, B. S., E. E.

CONTENTS.

CHAPTER I.—Properties of Alternating Currents.
CHAPTER II.—Self-Induction.
CHAPTER III.—Capacity.
CHAPTER IV.—Problems Concerning Alternating-Current Circuits.
CHAPTER V.—Alternators.
CHAPTER VI.—Transformers.
CHAPTER VII.—Induction Motors, Synchronous Motors, and Frequency Changers.
CHAPTER VIII.—Converters.
CHAPTER IX.—Power Transmission.
CHAPTER X.—Tests.

D. Van Nostrand Company

Publishers and Booksellers **23 Murray and 27 Warren Streets, New York**

Copies sent prepaid on receipt of price

"CECO"

ALTERNATORS

Give complete satisfaction wherever installed

BECAUSE

They are modern in design, accurate in construction and unequaled in performance.

WRITE FOR CATALOGUE

250 kw. 3-Phase "Ceco" Alternator.

Built in Capacities up to 1500 KW.

CHRISTENSEN ENGINEERING CO.
MILWAUKEE

CHICAGO: Old Colony Building
PITTSBURG: Gellatly & Co.
SAN FRANCISCO, SEATTLE } Kilbourne & Clark CO.

Browning Motors and Dynamos

HIGH GRADE AND MODERN IN EVERY WAY

Motors, ... 1-8 to 15 H. P.
Dynamos, ... 1-2 to 12 1-2 K. W.

WRITE FOR BULLETIN

The Browning Manufacturing Co.

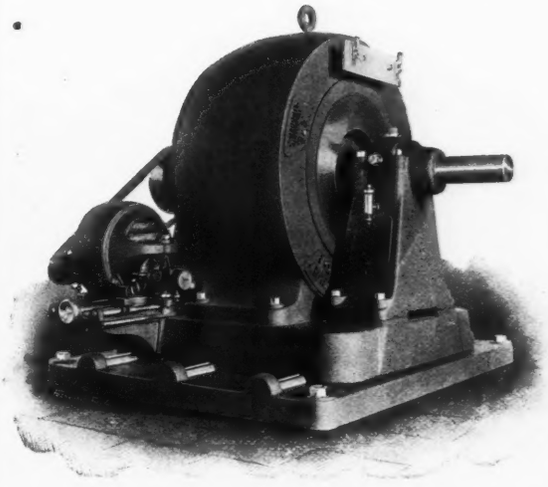
MILWAUKEE, U. S. A.

Eastern Representatives
D'OLIER ENGINEERING CO.
New York, Philadelphia, Baltimore

Southwestern Representatives
WESTERN ELECTRICAL SUPPLY CO.
St. Louis

Foreign Department: GOUDEY-McLEAN CO., 88 Maiden Lane, New York

THE WARREN ALTERNATOR



Nothing is so essential in electrical machinery as reliability and nothing contributes so much to reliability as simplicity

The Warren Alternator is a machine of the maximum simplicity.

It is simplicity itself having no slip rings or commutator and no revolving wire.

WARREN ELECTRIC MF'G. CO.

SANDUSKY, OHIO, U. S. A.

RUMSEY ELECTRICAL M'F'R'S CO., 1211 Filbert St., Philadelphia, Pa.
H. B. COHO & COMPANY, 114 Liberty St., New York
THOS. MUIR & SON, Detroit, Mich.
WESTERN ELECTRICAL SUPPLY CO., St. Louis, Mo.
C. W. HOBSON, Waco, Texas
KILBOURNE & CLARK CO., 815-817 Second Ave., Seattle, Wash., Pacific Coast Agents.
A. M. SEARLES, 1200 Fisher Building, Chicago, Ill.

General Electric Company's

MODERN ENCLOSED ARC LAMPS

Fifth Avenue, New York City

Light the Streets of the Principal Cities in the United States

---

GENERAL OFFICE, SCHENECTADY, N. Y.

New York Office, 44 Broad Street. Sales Offices in all Large Cities.

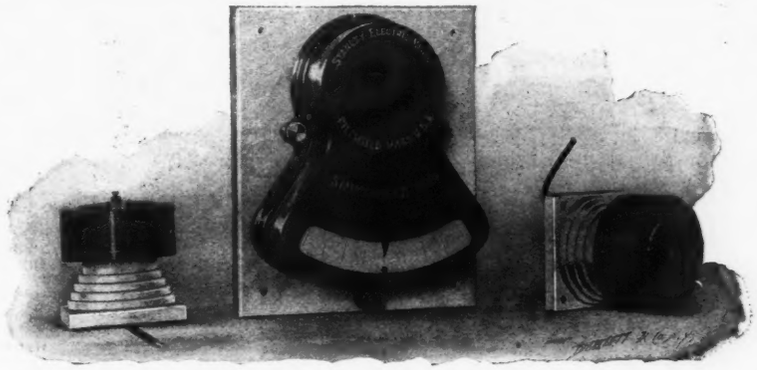
The SKC System

INSTRUMENTS

Hot Wire Ammeter in Hard Rubber Case, showing zero adjustment and short-circuiting switch.

Hot Wire Voltmeters and Ammeters have proven themselves to be the most satisfactory measuring instruments ever designed. Unlike all other types they operate independently of magnetic influences, and therefore they are unaffected by frequency, form of wave or by external magnetism and are correct on either direct or alternating circuits. They can be mounted wherever convenient, regardless of the propinquity of bus-bars or generators. The hot wire through which the current passes is mounted on a plate having the same temperature coefficient, therefore these instruments are absolutely unaffected by variations in temperature.

The **S. K. C. System** also includes **Wattmeters, Power Factor Indicators, Static Voltmeters and Static Ground Detectors** which, like our hot wire instruments, embody features of excellence which distinguish them from other apparatus of the kind. For example, in the **S. K. C. Ground Detector** illustrated herewith, the vanes are charged through the medium of condensers and high potential currents are thus kept entirely out of and away from the instrument.



A Type D Ground Detector and Its Condensers

Correspondence Invited

Stanley Electric Mfg. Company

Pittsfield, Mass.

NEW YORK, 29 Broadway.
CHICAGO, Monadnock Block.
BOSTON, Equitable Building.
PHILADELPHIA, 26 S. 15th St.
ST. PAUL, MINN., 131 East Fifth St.
BUFFALO, N. Y., 202 Main St.
DETROIT, MICH., Mich. Electric Co.
CLEVELAND, O., 129-131 Euclid Ave.
SAN FRANCISCO, 31-33 New Montgomery St.
LOS ANGELES, CAL., Douglas Bldg.
DENVER, COLO., Hendrie & Bolthoff Mfg. & Supply Co.
SEATTLE, WASH., Pioneer Bldg.
BUTTE, MONT., Western Mining Supply Co.
ATLANTA, GA., Empire Building.

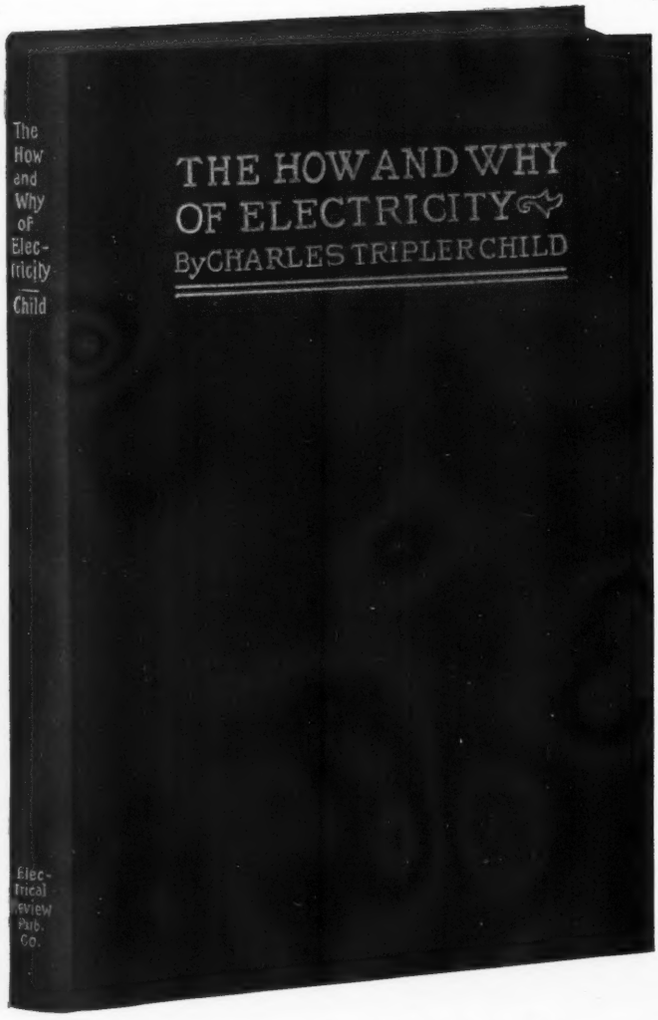
In Canada S. K. C. Apparatus is manufactured by the CANADIAN GENERAL ELECTRIC CO., TORONTO.

Lillibridge, N. Y., 25-1205

"The How and Why of Electricity"

By CHARLES TRIPLER CHILD, Late Technical Editor of the Electrical Review

PRICE $1.00, POSTAGE PREPAID



CONTENTS

CHAPTER

Preface.
I The Electric Current.
II The Electric Battery.
III The Effects of Electric Flow in the Circuit—Heat and Chemical Action.
IV The Effects of Electric Flow Outside the Circuit—Magnetism and Induction—The Electrical Units.
V Electromagnets—The Telegraph.
VI Electric Signaling Apparatus.
VII The Relations Between Magnets and Electric Currents.
VIII Induction and Reactive Coils.
IX The Telephone.
X Telephone Accessories.
XI The Mechanical Generation of Electricity.
XII The Dynamo Machine.
XIII Various Types of Dynamo Machines.
XIV Alternators—Polyphase Currents.
XV The Electric Motor.
XVI The Electric Railway.
XVII Polyphase Currents and Motors.
XVIII Electrical Power Transmission.
XIX The Incandescent Light.
XX The Arc Light.
XXI Electrochemistry—Storage Batteries.
XXII Wireless Telegraphy.
XXIII Radiation—X-Rays.

"The descriptions are helped out with cuts and diagrams that really explain. We know nothing that gives so much help on a difficult and complex matter in so short a space."—*New York Sun, December 27, 1902.*

"Is admirably adapted to instruct the non-technical reader who is interested in that subject. * * * Mr. Child enjoyed a high reputation for the clearness and intelligibility of his writing, and the volume in question exhibits these qualities."—*New York Tribune, December 26, 1902.*

"We can unhesitatingly recommend this book to all non-technical readers, who desire a simple and yet correct account of the different features of modern electrical development."—*Street Railway Journal, New York, January 10, 1903.*

"An excellent manual of the uses of electricity, and while not intended in any way as a text-book, the work is of much value to readers, both professional and lay."—*National Electrical Contractor.*

"Mr. Child has left a good book; one that we can heartily commend to the non-technical readers for whom it was written; they will not be led astray by platitudinous nonsense, but will receive solid, exact information, if simply expressed."—*Western Electrician, Chicago, February, 21, 1903.*

"The book is a handy one; just what nine men in ten demand in order to seize rapidly the practical side of electricity."—*San Francisco Chronicle, February 7, 1903.*

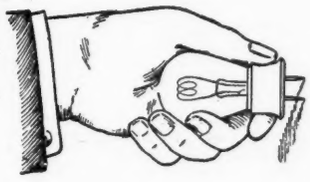
"In spite of the great mass of electrical literature already existing, it is one of the first good books of its kind. * * * It will find a large circle of readers on its evident merits."—*Engineering News, New York, February 19, 1903.*

Address **ELECTRICAL REVIEW**

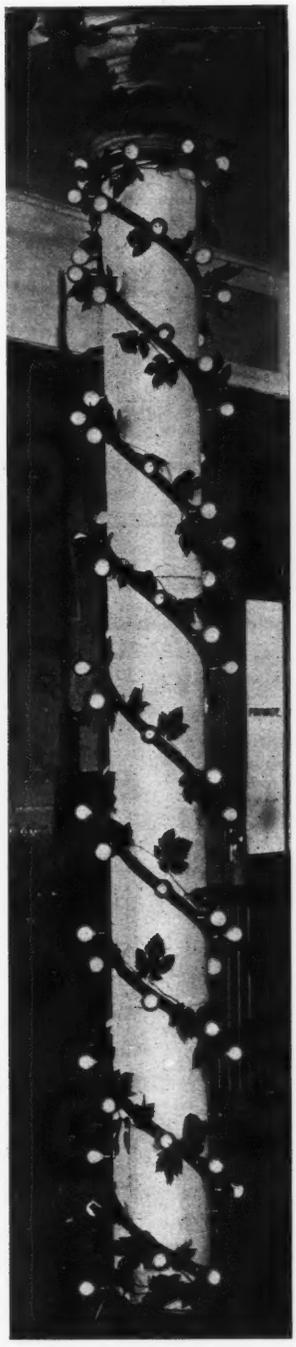
BOOK DEPARTMENT **13 PARK ROW, NEW YORK**

ELBLIGHT

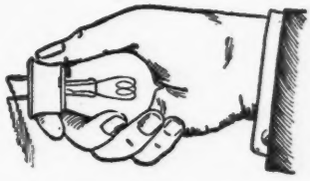
"Wherever you stick the lamp it lights."



The only System of Decorative Lighting approved by the National Board of Fire Underwriters.



"Wherever you stick the lamp it lights."



The only System of Decorative Lighting approved by the National Board of Fire Underwriters.

Water proof

Gas proof

Decoration by the Elblight System: Put up in 20 Minutes, down in 5 Minutes.

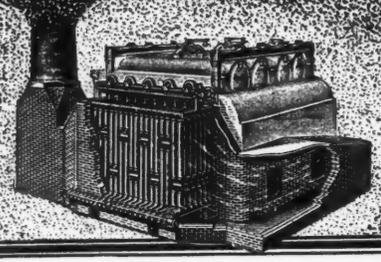
Elblight Lamps can be inserted with Ease at any point in the Cable.

Elblight Company of America

114 West Thirty-second Street, - New York

GREEN'S ECONOMIZER

SAVES 10 TO 20% IN FUEL



An item worth considering at the present price of coal

Special designs for ELECTRIC LIGHT and POWER PLANTS

See our free booklet "Green's Economizer" for detailed information

THE GREEN FUEL ECONOMIZER COMPANY

MATTEAWAN, N. Y.

Sole manufacturers in the U. S. A.

Automatic High Speed Vertical and Horizontal Engines

Gas and Gasoline Generating Installations, Direct-Connect or Belted

Automatic and Positive Lubrication Combined with Filter System

MANUFACTURERS DIRECT SELLING REPRESENTATIVES PROMPT DELIVERIES EFFICIENT SERVICE

H. E. MAXFIELD & CO., 136 Liberty St., New York, U.S.A.

ALPHABETICAL INDEX.—(*Continued from page 20.*)

K

Keystone Electric Co. 30
Kinsman Electric and Railway Supply Co. 25
Klein & Sons, Mathias. 58
Knott Apparatus Co., L. E. 46
Knowles, Edward R. 53

L

Lamp Testing Bureau 17
Lawrence Hall Electric Co. 48
Leeds & Northrup Co. 21
Leffel & Co., James 28
Le Valley Vitae Carbon Brush Co. 62
Lombard Governor Co. 28
Lowell Model Co 45
Lunkenheimer Co. 62
Lyndon, Lamar 53
Lyon Metallic Mfg. Co.

M

Machado & Roller 21
Magnet Wire Co. 1
Manhattan Electrical Supply Co. 48
Manross, F. N.
Marshall, Wm. 48
Marshall-Sanders Co. 33
Massachusetts Chemical Co. 9
Maxfield & Co., H. E 24
McGill University 51
McIntire Co., The C. 15
McTighe, Thos. J. 53
Mead Cycle Co. 55
Mechanical Boiler Cleaner Co.
Menchen, Joseph P. 55
Mica Insulator Co. 42
Michigan Central R.R.
Michigan College of Mines. 51
Milwaukee Electric Co.
Monarch Fire Appliance Co. 31
Montauk Fire-Detecting Wire Co. 1
Morse Twist Drill Co. 49
Munsell & Co., Eugene.
Murdock, H. D.
Murdock Corporation 19

N

National Battery Co. 6
National Carbon Co. 5
National Conduit & Cable Co. 1
National Electric Co. 38
National India Rubber Co
Nernst Lamp Co.
New England Butt Co. 10
New England Engineering Co. 7,53
New England Motor Co. 36
New Process Raw Hide Co. 51
New York & Ohio Co. 1
New York Cen. & Hudson Riv. R. R. 49,57
New York Insulated Wire Co. 1
New York Telephone Co. 57
North Electric Co. 59
Okonite Co. 1,11

O

Osborn-Morgan Co. 15
Osburn Flexible Conduit Co 1,56
Ostrander, W. R. & Co. 31
Otis Elevator Co. 15

P

Pacific Electric Co. 17
Pairpoint Corporation. 17
Paiste Co., H. T. 32
Parsell & Weed. 48
Peerless Electric Co. 41
Pennsylvania R. R. 31
Phelan, D. W. 58
Phœnix Glass Co 1
Prometheus Electric Co.
Phelps Co. 18,45
Phillips, Eugene F., Bare and Insulated Wires. 1
Phillips Insulated Wire Co. 62
Phosphor-Bronze Smelting Co. 21
Pignolet, Louis M. 21
Pittsburg Sewer Pipe and Conduit Co. 27
Portland Co., The 45
Power Installation Co. 53
Powers Co., The E. L. 53
Prentiss Clock Improvement Co. 48
Prometheus Electric Co.

R

Rae, Frank B. 53
Rappel, E. F. P. 55
Reuterdahl, Arvid. 53
Reuterdahl Electric Co. 6
Risdon-Alcott Turbine Co. 28
Rittenhouse-Miller Co. 26
Robbins & Myers Co 15
Rope Fibre Pulley Covering Co. 45
Robertson & Sons, Jas. L.
Roebling's Sons Co., John A. 62
Rooney-Westbury Elec. Lamp Co.
Rose Polytechnic Institute. 51
Rossiter, MacGovern & Co. 46
Runyon, F. O. 53
Russell Tomlinson Elec Co. 56

S

Safety Insulated Wire & Cable Co. 10
Samson Cordage Works. 45
Schapirograph Co. 48
Schwerdtle Stamp Co. 51
Shelby Electric Co. 1,17
Siggers & Siggers 45
Sills-Eddy Mica Co. 31
Simplex Electrical Co 1
Simplex Electric Heating Co. 48
Smith Storage Battery Co. 6
Smith & Hemenway Co. 49
Spcer Carbon Co.
Sprague Electric Co. 42
Standard Electric Mfg. Co. 24

(*Continued on page 28.*)

ANY CANDLE POWER — STAR — ALL VOLTAGES

This Label on incandescent lamps guarantees best quality lamps

STANDARD ELECTRIC MFG. CO., Niles, Ohio

STOP! LISTEN! LOOK AROUND!

Before Contracting for

INCANDESCENT LAMPS

Get the STERLING SPECIAL Literature.

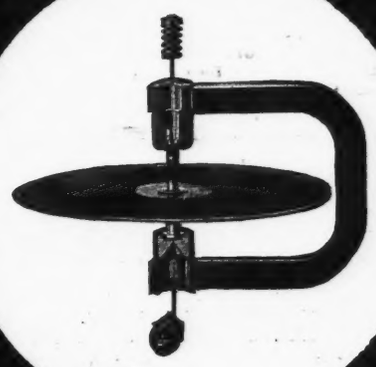
STERLING ELECTRICAL MFG. CO.

Warren, Ohio.

THE ELECTRICAL REVIEW Reaches and is read by the men you wish to do business with

MAGNETIC SUSPENSION
STANLEY
RECORDING WATTMETERS

NO WEAR.
NO FRICTION.
NO REVENUE LOST.



RECORDS ALL CURRENT USED.

WRITE FOR BOOKLET "ABOUT METERS"

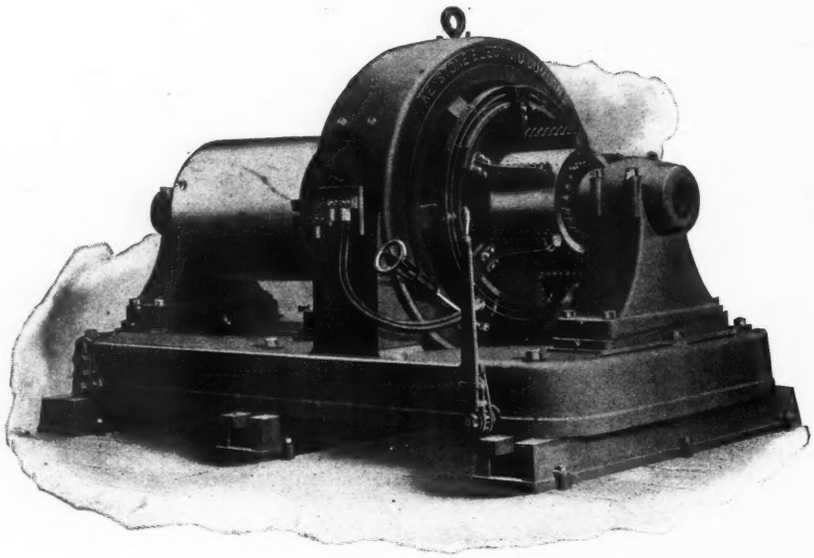
STANLEY INSTRUMENT CO.
GREAT BARRINGTON, MASS.

European Office: 23 Boulevard des Italians, Paris.

SALES AGENTS
FOR PACIFIC COAST—JNO. MARTIN & CO., San Francisco, Cal., Los Angeles, Cal., and Seattle, Wash.
FOR COLORADO, IDAHO, MONTANA, NEW MEXICO and WYOMING—THE HENDRIE & BOLTHOFF M'F'G & SUPPLY CO., Denver, Col.
FOR MEXICO—VICTOR M. BRASCHI & BRO., Mexico City

The Keystone Electric Company

Erie, Pa.



High Grade Electrical Machinery

Direct-Current Generators and Motors for all Lighting and Power Purposes

All Types and Sizes up to 1000 K. W. Direct-Connected, Geared or Belted.

New York Office: 114 Liberty Street
H. B. Coho & Co.

Chicago Office: Old Colony Building
Geo. H. Stout

MAGNETIC SUSPENSION

STANLEY RECORDING WATTMETERS.

NO WEAR
NO FRICTION.

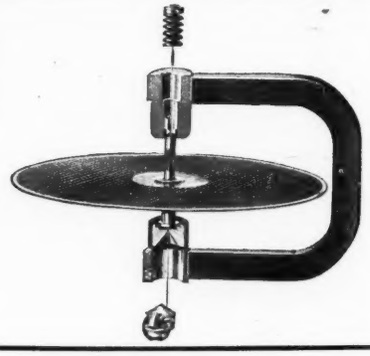
NO REVENUE LOST.
ALL CURRENT USED RECORDED.

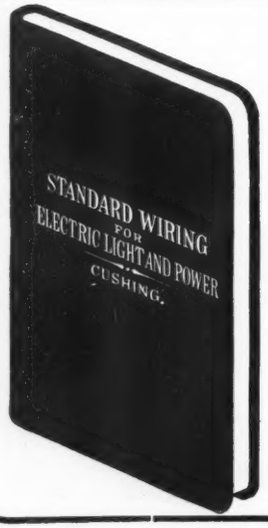
Send for description and book full of good information

"ABOUT METERS."

STANLEY INSTRUMENT CO., Great Barrington, Mass., U. S. A.
EUROPEAN OFFICE, 23 Boulevard des Italiens, Paris, France.

SALES AGENTS
- FOR PACIFIC COAST—JNO. MARTIN & CO., San Francisco, Cal., Los Angeles, Cal., and Seattle, Wash.
- FOR COLORADO, IDAHO, MONTANA, NEW MEXICO and WYOMING— THE HENDRIE & BOLTHOFF M'F'G & SUPPLY CO., Denver, Col.
- FOR MEXICO—VICTOR M. BRASCHI & BRO., Mexico City





THE 1908 EDITION

Standard Wiring

For Electric Light and Power

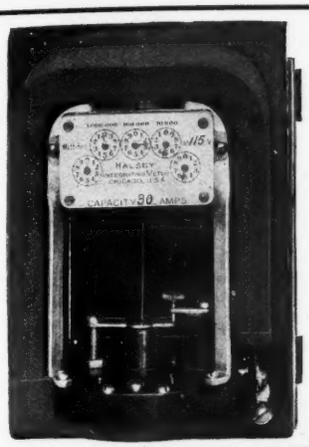
By H. C. CUSHING, Jr., A. I. E. E., Electrical Engineer and Inspector.

ADOPTED By the Fire Underwriters of the United States
By Cornell University, Stanford University and other Technical Colleges and Schools
By over 47,000 Electrical Engineers, Central Station Managers and Wiremen

BECAUSE It is the only book on Wiring and Construction kept strictly up to date
It contains all the necessary Tables, Rules, Formulas and Illustrations
It settles disputes, and if referred to before wiring will prevent disputes

FLEXIBLE LEATHER COVER (Pocket Size) $1. Sent post paid upon receipt of price, by

ELECTRICAL REVIEW PUB. CO., 13-21 Park Row, NEW YORK



DIRECT CURRENT
MOTOR TYPE METER

Most Permanent — No Current Losses
Most Accurate — No Commutator
Most Reliable — No Brushes
Most Simple — No Jewel

Runs on very small fraction of 1 per cent of rated capacity. Absolutely cannot run on the pressure. Write and learn many other advantages.

Edward S. Halsey Manf'r.

ELECTRICAL AND MECHANICAL SPECIALTIES

94 E. Chicago Avenue, Chicago, U. S. A.

ANYTHING IN REFLECTORS

If you don't find what you require listed in our Catalogue, send us your specifications and we can make it.

We are the Largest Manufacturers

WHEELER REFLECTOR CO.

156 PEARL STREET, BOSTON
Foreign Department, 120 Liberty Street, New York City

Voltmeters, Ammeters, and Volt-Ammeters . . .

POCKET SIZE,
VARIOUS RANGES,
ACCURATE,
RELIABLE.

For General Measurements, Testing Storage and Primary Batteries, Circuits, Etc.

L. M. PIGNOLET,
Manufacturer of ELECTRIC INSTRUMENTS, and ELECTROTHERAPEUTIC APPARATUS.
78 Cortlandt Street, New York.

PLATINUM
IN SHEET OR WIRE FOR ALL PURPOSES
SCRAP PURCHASED.
AMERICAN PLATINUM WORKS,
Formerly CHARLES F. CROSELMIRE. 251 to 265 New Jersey R. R. Ave. NEWARK, N. J.

FOR CONTINUED CONTACT WITH COPPER — CHEMICALLY INERT

DIELECTROL

COIL CEMENT — DIELECTRIC MNFG. CO. SAINT LOUIS

JEWELL INSTRUMENTS

For Direct Current only, are used by discriminating engineers

Portable Instrument

The portable instruments made by us are equally as accurate as our special laboratory meters, but are smaller in size. Each instrument is provided with a neat hard-wood carrying case.

Jewell Electrical Instrument Company
61-63 Union Park Court, cor. Carroll Ave., Chicago, Ill., U. S. A.

REG. TRADE MARKS

THE PHOSPHOR BRONZE SMELTING CO. LIMITED,
2200 WASHINGTON AVE., PHILADELPHIA.
"ELEPHANT BRAND PHOSPHOR-BRONZE"
INGOTS, CASTINGS, WIRE, RODS, SHEETS, ETC.
— DELTA METAL —
CASTINGS, STAMPINGS AND FORGINGS.
ORIGINAL AND SOLE MAKERS IN THE U.S.

EVERY : : : : :
ELECTRIC LIGHT
GENERAL MANAGER

Reads the *Electrical Review* weekly. An inquiry will substantiate this. Do you wish him to see your advertisement?

THE HUBBELL UNIVERSAL ATTACHMENT PLUG

BASE SCREWS IN — CAP SNAPS ON

Made for new and old code cord or cable.
No twisting of the wire.
Best plug for the fan motor.
For sale by all the jobbers.

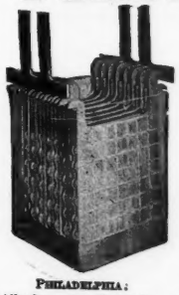
Manufactured by
HARVEY HUBBELL
MAIN OFFICE & FACTORY, BRIDGEPORT, CONN.
96 Nassau St., New York — Chicago

THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA

MANUFACTURER OF THE

"Chloride Accumulator"



For Central Stations, Electric Railways, Isolated Lighting and Power Stations, Fire Alarm, Telegraph, Train Lighting, etc., etc.

PRICE LISTS AND DESCRIPTIVE BULLETINS FORWARDED UPON REQUEST

— SALES OFFICES —

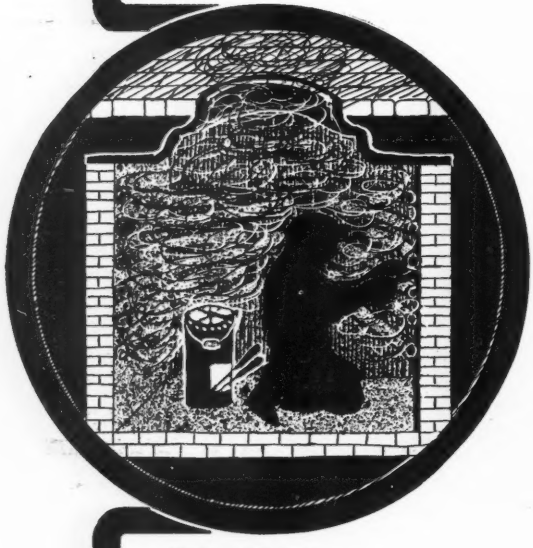
PHILADELPHIA: Allegheny Ave. & 19th St.
NEW YORK: 160 Broadway
BOSTON: 60 State Street
CHICAGO: Marquette Bldg.
BALTIMORE: Continental Trust Bldg.
ST. LOUIS: Wainwright Bldg.
SAN FRANCISCO: Nevada Block
CLEVELAND: Citizens Bldg.
HAVANA CUBA: G. F. Greenwood, Manager 34 Empedrado Street

A Perfect Electrical Cable Joint

No Solder—No Ruined Insulation—No High Resistance Air-Gaps. A Positive Contact Assured. Easy of Application. Will Never Break Down nor Come Apart

Fig. 1.

THE DOUBLE CONICAL EXPANSION JOINT



THE OLD WAY

THE EXPANSION PLUG TERMINAL

The cable is inserted in the tapered thimble and drawn into positive contact by means of the flanged outside sleeve.

THE NEW WAY

Fig. 2.

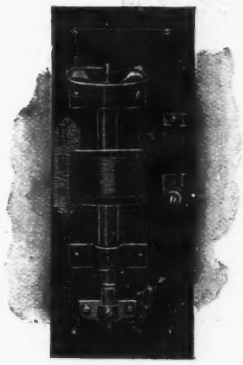
THE DOUBLE CONICAL EXPANSION JOINT

The cable is inserted into the tapered thimble, and a hole is started in the cable by a nail or a "centre punch," the ends of the conical wedge are then put in place and the external flanged and threaded sleeves are drawn together, forcing the soft copper plug into a homogeneous mass which carries all the current with no increase in resistance.

THE ELECTRIC CABLE JOINT AND APPLIANCES CO.

PARK ROW BUILDING, NEW YORK CITY

ELECTRICAL REVIEW



YOU TAKE NO CHANCES

WHEN YOU BUY

GARTON LIGHTNING ARRESTERS

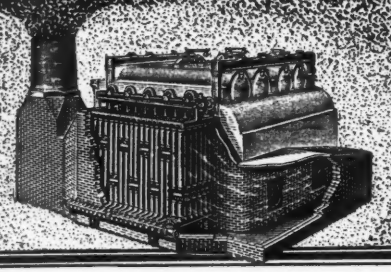
THEY GIVE AN OUTLET TO THE DISCHARGE OF SUCH LOW RESISTANCE THAT YOU ARE INSURED ABSOLUTE PROTECTION DURING ALL STORMS, IF ENOUGH ARE USED. WE TELL YOU HOW MANY.

We agree to repair or replace any Garton Arrester damaged by Lightning within one year of date of sale. This removes all doubt as to durability.

GARTON-DANIELS CO., Keokuk, Ia., U. S. A.

GREEN'S ECONOMIZER

SAVES 10 TO 20% IN FUEL



An item worth considering at the present price of coal

Special designs for ELECTRIC LIGHT and POWER PLANTS

See our free booklet "Green's Economizer" for detailed information

THE GREEN FUEL ECONOMIZER COMPANY

MATTEAWAN, N. Y.

Sole manufacturers in the U. S. A.

Micabeston IS THE BEST INSULATOR for Commutators

Imperial Varnish Cloth IS THE BEST INSULATOR for Armatures

SILLS-EDDY MICA COMPANY

CHICAGO NEW YORK

THE SIMPLEST, MOST PRACTICAL AND ECONOMICAL TURN-DOWN ELECTRIC LAMP EVER INVENTED

The ECONOMICAL

Style 1—Pull string for bright or dim. Style 2—For variation in light turn bulb one way or the other. Write for booklet and prices. All voltages and bases.

ECONOMICAL ELECTRIC LAMP CO. 123 LIBERTY STREET NEW YORK

STUART-HOWLAND CO.

Largest Line of RAILWAY, TELEPHONE and LIGHTING SUPPLIES in New England

4-5 WINTROP SQUARE and 261-287 DEVONSHIRE ST.

BOSTON

ANY CANDLE POWER — STAR STANDELEC MANF'G CO. NILES OHIO. U.S.A. — ALL VOLTAGES

This Label on incandescent lamps guarantees best quality lamps

STANDARD ELECTRIC MFG. CO., Niles, Ohio

ALPHABETICAL INDEX.—(*Continued from page 36.*)

K

Keystone Electric Co. 28
Kinsman Electric and Railway Supply Co. 3
Klein & Sons, Mathias. 88
Knott Apparatus Co., L. E. 26
Knowles, Edward R. 85

L

Lamp Testing Bureau. 78
Lawrence Hall Electric Co. 51
Leeds & Northrup Co. 32
Leffel & Co., James. 44
Le Valley Vitae Carbon Brush Co. 84
Lombard Governor Co. 44
Lowell Model Co 76
Lunkenheimer Co. 92
Lyndon, Lamar. 85
Lyon Metallic Mfg. Co.

M

Machado & Roller.
Magnet Wire Co. 1,26
Manhattan Electrical Supply Co. 78
Manross, F. N. 16
Marshall, Wm. 78
Marshall-Sanders Co. 49
Massachusetts Chemical Co. 9
McGill University. 77
McIntire Co., The C. 16
McTighe, Thos. J. 85
Mead Cycle Co. 77
Mechanical Boiler Cleaner Co.

M

Menchen, Joseph P. 84
Mica Insulator Co. 50
Michigan Central R.R. 34
Michigan College of Mines. 77
Michigan Electric Co. 78
Milwaukee Electric Co. 27
Monarch Fire Appliance Co. 6
Montauk Fire-Detecting Wire Co. 1
Morse Twist Drill Co. 79
Munsell & Co., Eugene. 58
Murdock, H. D.
Murdock Parlor Grate Co. 26

N

Nassau Light & Power Co. 70
National Battery Co. 50
National Carbon Co. 5
National Conduit & Cable Co. 1
National Electric Co. 31
National India Rubber Co 1
Nernst Lamp Co. 90
New England Butt Co. 10
New England Engineering Co. 7,85
New England Motor Co. 26
New Process Raw Hide Co. 69
New York & Ohio Co. 1
NewYorkCen.& Hudson Riv.R.R. 84
New York Insulated Wire Co. 1
New York Telephone Co. 87
North Electric Co. 86
Okonite Co. 1,11

O

Osborn-Morgan Co. 16
Osburn Flexible Conduit Co 1,56
Ostrander, W. R. & Co. 77
Otis Elevator Co. 16

P

Pacific Electric Co. 21
Pairpoint Corporation.
Paiste Co., H. T. 48
Parsell & Weed. 77
Peerless Electric Co. 14,15
Pennsylvania R. R. 38
Phelan, D. W. 88
Phœnix Glass Co 1,34
Prometheus Electric Co.
Phelps Co. 30,75
Phillips, Eugene F., Bare and Insulated Wires. 1
Phillips Insulated Wire Co. 92
Phosphor-Bronze Smelting Co. 37
Pignolet, Louis M 37
Pittsburg Sewer Pipe and Conduit Co. 23
Portland Co., The 67
Power Installation Co. 85
Powers Co., The E. L. 85
Prentiss Clock Improvement Co. 78
Prometheus Electric Co. 35
Pullen Electric Co., Leon W. 6

R

Rae, Frank B. 85

R

Rappel, E. F. P. 77
Reuterdahl, Arvid. 85
Reuterdahl Electric Co. 50
Risdon-Alcott Turbine Co. 44
Rittenhouse-Miller Co. 24
Robbins & Myers Co 17
Rope Fibre Pulley Covering Co. 75
Robertson & Sons, Jas. L. 78
Roebling's Sons Co., John A. 92
Rooney-Westbury Elec. Lamp Co. 76
Rose Polytechnic Institute. 77
Rosenberg Co., E. 17
Rossiter, MacGovern & Co. 81
Runyon, F. O. 85
Russell Tomlinson Elec. Co. 86

S

Safety Insulated Wire & Cable Co. 10
Samson Cordage Works. 76
Schapirograph Co. 78
Schwerdtle Stamp Co. 78
Shelby Electric Co. 21
Siggers & Siggers. 75
Sills-Eddy Mica Co. 40
Simplex Electrical Co 1
Simplex Electric Heating Co. 76
Smith Storage Battery Co. 50
Smith & Hemenway Co. 79
Speer Carbon Co. 92
Sprague Electric Co. 29,58

(*Continued on page 44.*)

MAGNETIC SUSPENSION

STANLEY RECORDING WATTMETERS.

NO WEAR
NO FRICTION.

NO REVENUE LOST.
ALL CURRENT USED RECORDED.

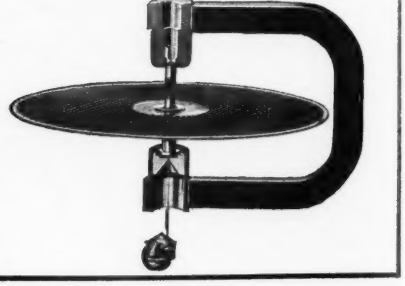
Send for description and book full of good information

"ABOUT METERS."

STANLEY INSTRUMENT CO., Great Barrington, Mass., U. S. A.

EUROPEAN OFFICE, 23 Boulevard des Italiens, Paris, France.

SALES AGENTS
FOR PACIFIC COAST—JNO. MARTIN & CO., San Francisco, Cal., Los Angeles, Cal., and Seattle, Wash.
FOR COLORADO, IDAHO, MONTANA, NEW MEXICO and WYOMING—THE HENDRIE & BOLTHOFF M'F'G & SUPPLY CO., Denver, Col.
FOR MEXICO—VICTOR M. BRASCHI & BRO., Mexico City



TAKE THE SAFE CHANNEL.

Do not run against the rocks of false claims, but be guided by the light of experience.

The Buckeye lamp has led in every improvement introduced in lamp manufacture in the last ten years. It has the original cellulose filament. Other manufacturers were from three to five years in adopting this vital step.

Buckeye machinery for producing **uniformity** in lamps has a world-wide celebrity, and is copied everywhere.

Every Buckeye lamp has **31 rigid inspections,** besides many minor inspections, by which satisfaction is guaranteed.

If you don't want to guess you had **Better Buy Buckeye.**

BUCKEYE ELECTRIC COMPANY,

Main Sales Office and Works, - CLEVELAND, OHIO.

BRANCHES: CHICAGO, Monadnock Building.
PITTSBURG, Real Estate Trust Building.
PHILADELPHIA, Real Estate Trust Building.

Agencies:
C. S. Knowles, Boston, Mass.
Henry L. Walker Co., Detroit, Mich.
Dunham, Carrigan & Hayden, San Francisco.
Waco Supply & Plumbing Co., Waco, Texas.
Post-Glover Electric Co., Cincinnati, Ohio.
Erner-Hopkins Elec. Co., Columbus, Ohio.

J A N

Enclosed Arc Lamps

Electric

CHALLENGE ALL

Agencies in all

THE JANDUS

CLEVELAND

115 Broadway
NEW YORK

Monadnock
CHIC

D U S

Small Power Motors

Fans

COMPETITION

Large Cities

ELECTRIC CO.

OHIO

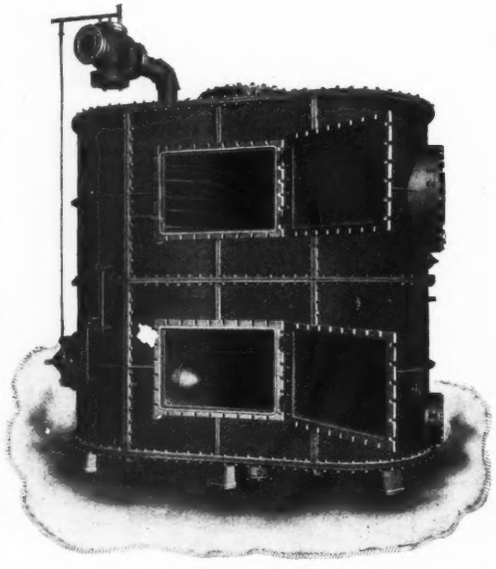
Building

AGO

Real Estate Trust Building

PHILADELPHIA

Saves FUEL—Saves BOILERS



A Stilwell Feed Water Heater is an important adjunct to steam power plants, because for every 10 degrees added to the temperature of feed water, about 1 per cent of the total cost for fuel will be saved. 210 degrees is easily obtainable with sufficient exhaust steam, as every facility is provided for bringing the steam and water together in such a way as to heat it to the highest possible temperature.

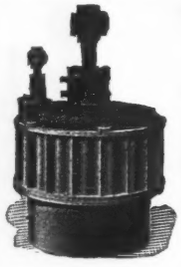
At the same time the water is freed from scale-producing elements, keeping the boilers free from scale and adding to their life.

We also make Steam, Power and Electric Pumping Machinery, Jet and Surface Condensers, Air Compressors, Victor Turbines, Oil Mill Machinery and Filter Presses.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY

NEW YORK: 141 Broadway PHILADELPHIA: 619 Arch Street CHICAGO: 311 Dearborn Street
NEW ORLEANS: 304 Hennen Building CLEVELAND: 1116 New England Building
BALTIMORE: 1507 Continental Trust Building BOSTON: 73 Oliver Street SAN FRANCISCO: 11-13 First Street
Sales Agents: FREDERIC NELL, 97 Queen Victoria St., London, England E. F. AUSTIN, Smith Block, Pittsburg

Dayton, Ohio, U. S. A. 1



TURBINES

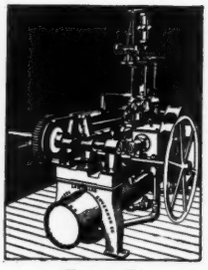
UPRIGHT AND HORIZONTAL
For ELECTRIC POWER and LIGHTING PLANTS

RISDON TURBINE
gives the highest full gate results of any Turbine ever made.

ALCOTT HIGH DUTY TURBINE
High speed and efficiency. Great strength. Close regulation and steady motion.

TAYLOR SLEEVE GATE TURBINE
The largest power ever obtained from a wheel of the same diameter.

RISDON - ALCOTT TURBINE CO.
Write for Catalogue. MOUNT HOLLY, NEW JERSEY, U. S. A.



Type B

OUR
Water Wheel Governors
ARE THE
Standard of the World

Twelve types controlling 400,000 horse-power are in use.
Write for catalogue and list of several hundred plants where they are in use.

The Lombard Governor Co.
36 WHITTIER ST., BOSTON, MASS.

ALPHABETICAL INDEX.

(*Continued from page 40.*)

S

Standard Electric Mfg. Co.....35,40
Standard Paint Co..... 58
Standard Pole & Tie Co..... 88
Standard Underground Cable Co.. 1
Standard Vitrified Conduit Co..... 25
Stanley Electric Mfg. Co..... 1
Stanley Instrument Co.....33,40
Stanley & Patterson..... 6
Stanton, Le Roy W..... 85
Star Porcelain Works..... 75
Sterling Electrical Mfg. Co..... 52
Sterling Varnish Co.. 58
Stevens, Horace J..... 51
Stilwell-Bierce & Smith-Vaile Co.. 44
Stirling Co..... 79
Stow Manufacturing Co..... 32
Stromberg-Carlson Telephone Mfg. Co..... 89
Stuart-Howland Co..... 40
Swedish-American Telephone Co.. 87

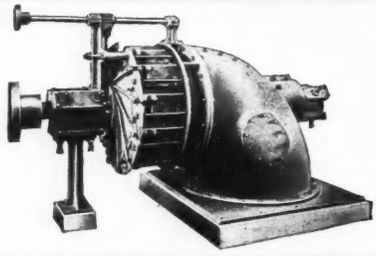
T

Thresher Electric Co.... 30
Toomey, Frank..... 79
Tulley & Co., Henry C..... 24

U

United Electric Heating Co. 26
U. S. Battery Co..... 1
U. S. Mineral Wool Co. 26
University of Wisconsin..... 77

SAMSON TURBINE



The SAMSON has a QUICKER SPEED than any other turbine of the same dimensions, operating under the same conditions. This is a decided advantage because it allows the use of LIGHTER and consequently CHEAPER TRANSMISSION MACHINERY.

JAMES LEFFEL & CO., Springfield, Ohio, U. S. A.
(3)

U

Utica Drop Forge & Tool Co..... 79

V

Vail, J. H..... 85
Valentine-Clark Co..... 88
Viaduct Mfg. Co..... 87
Vindex Electric Co..... .....
Vought-Berger Co..... 87

W

Waclark Wire Co..... 10
Wagner Electric Mfg. Co..... 28
Wanted..... 78
Warren Electric Mfg. Co..... 29
Warren Electric & Specialty Co.. 1
Weiss, W. F..... 78
Westcott, Geo. F..... 85
Western Electric Co..... 7
Western Electrical Supply Co....
Western Telephone Mfg. Co..... 87
Westinghouse Air Brake Co..... 2
Westinghouse Electric & Mfg. Co. 91

W

Weston Electrical Instrument Co.. 58
Wheeler Reflector Co..... 37
White & Co., J. G..... 85
White Star Appliance Co..... 21
Whitney Electrical Inst. Co .....
Wilmerding, C. H..... 85
Wyckoff Pipe & Creosoting Co... 58

Y

Yost Electric Mfg. Co..... 54

(*Continued on page 48.*)

THE BOY STOOD ON THE BURNING DECK

The Chip on his Shoulder.

Independent—
And we are.

IT WAS—
AND IS—
PRETTY HOT,
BUT
HE IS GOING
TO STAY
RIGHT
THERE

Pick up one of our lamps and compare it with any other lamp of ours. You will find they are as alike as a paper of pins. That is why we don't have to send you picked lamps on your sample order.

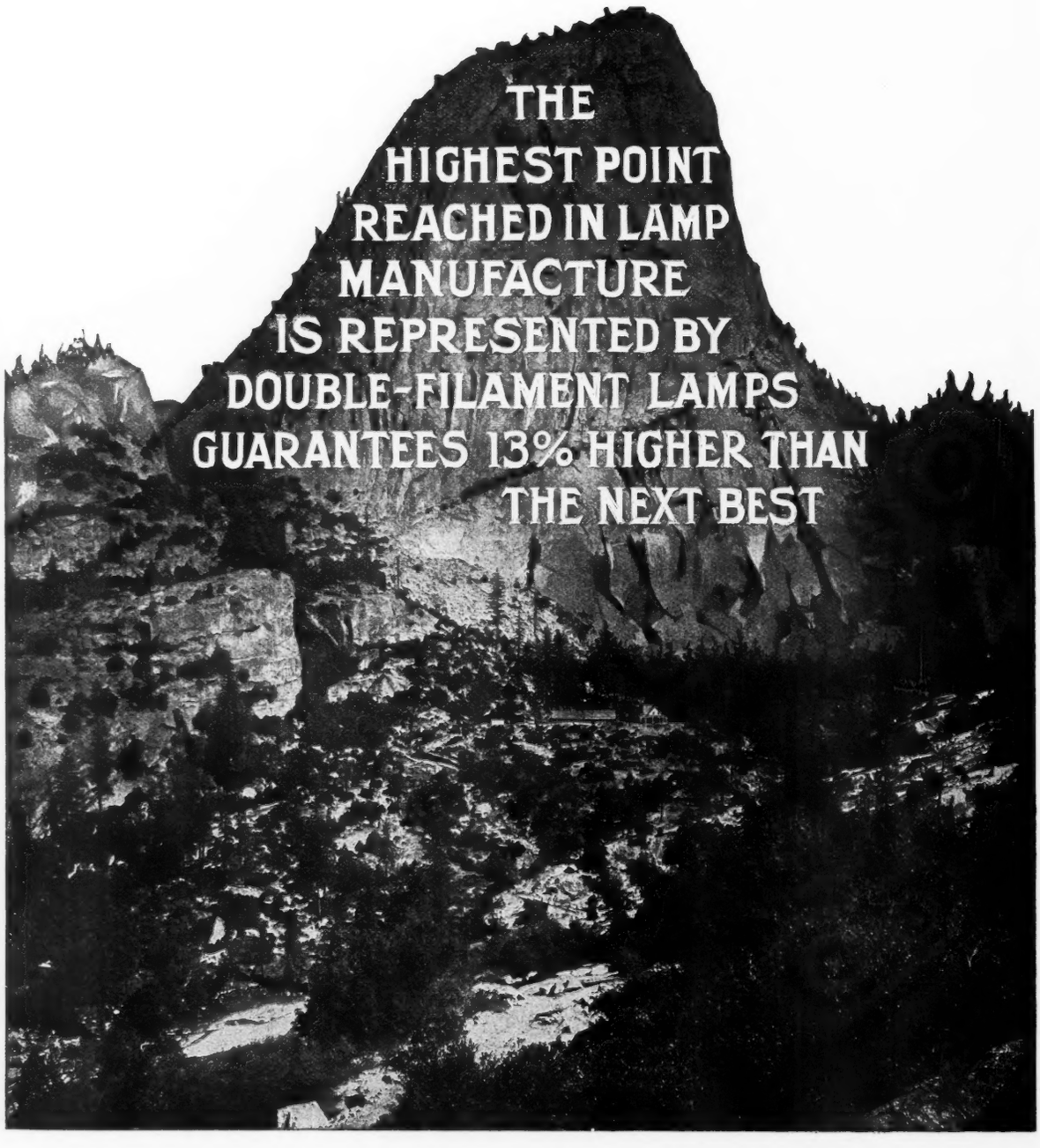
Regularity in lamp manufacture means a good deal to you. Perhaps you have never noticed the little points in lamp manufacture—how the tips differ; some long, some short, some crooked, some blackened. Then, again, did you ever look at the seals, where the platinum passes through the glass? Some lamps have large lumps where the copper wire joins the platinum. Many lamps have irregular shaped seals. All this means something, at least to the expert.

If the little things you can see are bad, what about the important points you can't see, such as initial candle-power and watts, maintained candle-power, life and regularity of performance?

You can depend upon Independent lamps in every one of these particulars.

THE INDEPENDENT INCANDESCENT LAMP COMPANY CLEVELAND, OHIO

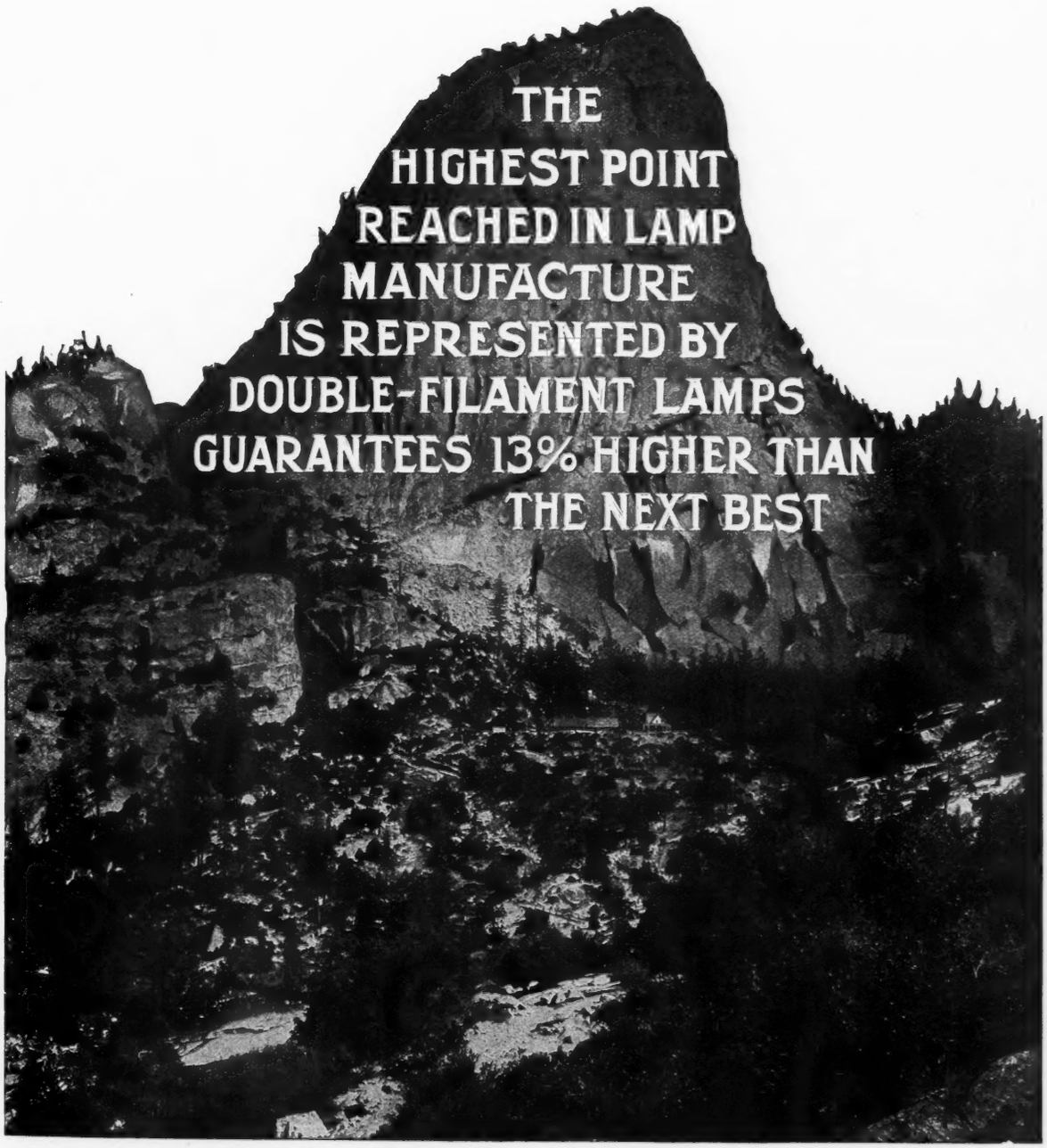
FACTORY: 78-84 SENECA ST.
OFFICE: ROSE BUILDING



BRYAN-MARSH COMPANY

New York, 136 Liberty St. Chicago, Fisher Building
Cincinnati, Perin Building Minneapolis, 1128 Lumber Exchange
San Francisco, Mills Building
Factory, Marlboro, Mass.

We believe this is good enough to say twice



BRYAN-MARSH COMPANY

New York, 136 Liberty St. Chicago, Fisher Building
Cincinnati, Perin Building Minneapolis, 1128 Lumber Exchange
San Francisco, Mills Building
Factory, Marlboro, Mass.

WHOLE-SALE ELECTRICAL SUPPLIES

Emerson Alternating-Current Fans will use less current and give more air than any other make. Lowest Market Price.

"EMERSON" Alternating CEILING DESK and EXHAUST FANS

Send for 1903 Fan Catalogue

DOUBLEDAY-HILL ELECTRIC COMPANY

PITTSBURG PA.

CLASSIFIED INDEX

(Continued from page 44.)

Adjusters, Incandescent Lamps.
Incan. Elec. Light Manipulator Co.
Pacific Electric Co.
Vought-Berger Co.

Air Compressors.
Stilwell-Bierce & Smith-Vaile Co.

Alternators.
Christensen Engineering Co.
Fort Wayne Electric Works.
General Electric Co.
National Electric Co.
Warren Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.

Armature Repairs.
Cleveland Armature Works.

Attachment Plugs.
Hubbell, Harvey.

Batteries, Primary.
American Carbon & Battery Co.
Bunnell & Co., J. H.
Burnley Battery & Mfg. Co.
Edison Mfg Co.
Pullen Electric Co., Leon W.

Batteries, Storage.
American Battery Co.
Dayton Electrical Mfg. Co.
Electric Storage Battery Co.
Gould Storage Battery Co.
National Battery Co.
Reuterdahl Electric Co.
Smith Storage Battery Co.
United States Battery Co.

Bells.
Ostrander & Co., W. R.

Belt Dressing.
Dixon Crucible Co., Joseph.

Boilers.
Allis-Chalmers Co.
Babcock & Wilcox Co., The.
Stirling Co., The.
Toomey, Frank.

Boiler Insurance.
Hartford Steam Boiler Insp. & In. Co.

Books, Technical.
E. L. Powers & Co.
Tulley & Co., Henry C.
Van Nostrand Co., D.

Brushes-Dynamo.
Le Valley Vitae Carbon Brush Co.
Speer Carbon Co.

Cable Hangers.
Standard Underground Cable Co.

Cabling Machines.
New England Butt Co.

Carbons.
American Carbon & Battery Co.
Consumers' Carbon Co.
Dickey-Sutton Carbon Co.
General Incandescent Arc Light Co.
National Carbon Co.
Speer Carbon Co.

Castings.
Christensen Engineering Co.
National Electric Co.
New England Butt Co.
Phosphor-Bronze Smelting Co., Ltd.

Circuit-Breakers.
Cutler-Hammer Mfg. Co.
Cutter Electrical & Mfg. Co.
Fort Wayne Electric Works.
Western Electric Co.

Cleaners, Incandescent Lamps.
Incan. Elec. Light Manipulator Co.

Climbers
Klein & Sons, Mathias.
Smith & Hemenway Co

Clusters.
Hubbell, Harvey.

Coal Handling Machinery.
C. W. Hunt Co.
The Jeffrey Mfg. Co.

Coal Mining Machinery.
General Electric Co.
The Jeffrey Mfg. Co.

Commutator Lubricant.
Allen & Co., L. B.

Commutator Segments.
Billings & Spencer Co.

Condensers (Electric).
Marshall, Wm.

Conduits.
Alphaduct Mfg. Co.
American Circular Loom Co.
American Conduit Co.
American Vitrified Conduit Co.
Camp Co., H. B.
Field, C. J.
Gest, G. M.
National Conduit & Cable Co.
Osburn Flexible Conduit Co.
Pittsburg Sewer Pipe & Conduit Co.
Rittenhouse-Miller Co.
Sprague Electric Co.
Standard Vitrified Conduit Co.
Wyckoff Pipe & Creosoting Co.

Conduit Benders.
Benson & Co., Wm. W.

Connectors
Smith & Hemenway Co.

Connectors and Terminals.
McIntire Co., The C.

Construction.
J. G. White & Co.
New England Engineering Co

Construction Supplies.
T. H. Brady.

Cross-Arms, Brackets, Pins, Ties, Climbers, Etc.
Central Electric Co.
Donnelly, John.
Eccleston Lumber Co.
Fowler, John H.
Klein & Son, Mathias.
Standard Pole & Tie Co.
Valentine-Clark Co.

Dynamos and Motors.
Akron Electrical Mfg. Co.
Browning Mfg. Co.
Bullock Electric Mfg. Co.
Central Electric Co.
Coho & Co., H. B.
Christensen Engineering Co.
Cleveland Armature Works.
Crocker-Wheeler Co.
Dustin Co., Chas. E.
Eck Dynamo & Motor Works.
Elwell-Parker Electric Co.
Fort Wayne Electric Works.
General Electric Co.
Gen'l Incandescent Arc Light Co.
Hobart Electric Mfg. Co.
Johnson, Charles F.
Keystone Electric Co.
Milwaukee Electric Co.
National Electric Co.
New England Motor Co.
Robbins & Myers Co.
Rossiter, MacGovern & Co.
Sprague Electric Co.
Stanley Electric Mfg. Co.
Stow Manufacturing Co.
Thresher Electric Co.
Toomey, Frank.
Wagner Electric Mfg. Co.
Warren Electric Mfg. Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Electric Lighters.
Electric Contract Co.
Stanley & Patterson.

Electric Locomotives.
General Electric Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.

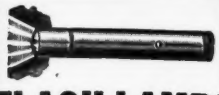
Electrical Instruments.
Bossert Electric Construction Co.
Bullock Electric Mfg. Co.
Bunnell & Co., J. H.
Ericsson Telephone Co.
Fort Wayne Electric Works.
Gen'l Incandescent Arc Light Co.
Lamp Testing Bureau.
Machado & Roller.
Pignolet, Louis M.
Wagner Electric Mfg. Co.

Electric Soldering Irons.
American Electrical Heater Co
Simplex Electrical Co.

Electrical Supplies.
Central Electric Co.
Crouse-Hinds Electric Co.
Electric Appliance Co
Ericsson Telephone Co.
Ewing-Merkle Electric Co.
Jones & Son, J.
Kinsman Electric & Railway Sup. Co.
Lawrence-Hall Electric Co.
Manhattan Electrical Supply Co.
Marshall-Sanders Co.
Michigan Electric Co.
Paiste Co., H. T.
Stanley & Patterson.
Western Electric Co.

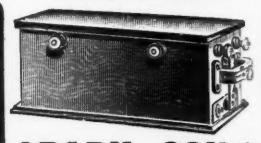
(Continued on page 85.)

EVENING STAR



FLASH LAMPS
AND OTHER ELECTRIC NOVELTIES
THE BEST AND CHEAPEST IN THE MARKET
WRITE FOR PRICES AND TERMS
ELECTRIC CONTRACT CO.
154 Lake St., Chicago 202-204 Centre St., N. Y.

WILLIAMS



SPARK COILS
Have been adopted by the leading manufacturers and supply houses

WHEN ADDRESSING ADVERTISERS PLEASE MENTION THIS PAPER

A wireman always finds
Six Good

P=K

250-VOLT

Attachment Plugs out of every half dozen.

There are no broken caps

H. T. PAISTE CO.
Chicago Philadelphia New York

Got a catalog?

A Fourth Reason

why the very best engineers specify Bullock Generators and Motors in every instance is because they have machine formed coils. This facilitates repairs, as it requires but a short time to replace an injured coil. Send for our descriptive bulletins.

Bullock Electric Mfg. Co.,
Cincinnati, U. S. A.

259

ELECTRICAL REVIEW

VOL. XLII—No. 21. NEW YORK, SATURDAY, MAY 23, 1903. TEN CENTS A COPY. THREE DOLLARS A YEAR. FIVE DOLLARS FOREIGN.

Copyright, 1903, by ELECTRICAL REVIEW PUB. CO.

THE PHOENIX GLASS CO.
Manufacturers of
Gas and Electric Globes, Shades, Etc.
Send for our LATEST CATALOGUE Now Ready
PITTSBURGH
NEW YORK
CHICAGO

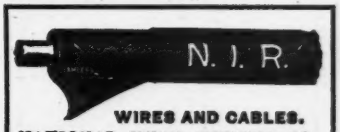
"Phono-Electric" Wire
"IT'S TOUGH"
Will give a security and permanence to your trolley, telephone or telegraph lines.

BRIDGEPORT BRASS CO.
19 Murray Street New York

AMERICA'S LARGEST ELECTRICAL SUPPLY HOUSE
ELECTRIC APPLIANCE COMPANY CHICAGO
92-94 WEST VAN BUREN ST.
ELECTRICAL SUPPLIES. SPECIALISTS ON METERS, TRANSFORMERS, LAMPS, ETC.

THE BRISTOL CO.
WATERBURY, CT.
Recording Voltmeters
Recording Amperemeters
Recording Wattmeters
Recording Pressure Gauges
Recording Thermometers
PAY FOR THEMSELVES
SEND FOR CATALOGUE

WILLARD L. CANDEE, M. DURANT CHESEVER, } Mgrs. GEO. T. MANSON, Gen. Supt. W. H. HODGINS, Secy.
1889 PARIS EXPOSITION MEDAL FOR RUBBER INSULATION
OKONITE
TRADE MARK
1893 WORLD'S FAIR MEDAL FOR RUBBER INSULATION
THE STANDARD FOR RUBBER INSULATION.
Sole Manufacturers of OKONITE WIRES, OKONITE TAPE, MANSON TAPE, CANDEE WEATHERPROOF WIRES. Write for Prices.
THE OKONITE CO., Ltd., 253 Broadway, New York.



WIRES AND CABLES.
NATIONAL INDIA RUBBER CO.
Factory and General Offices:
BRISTOL, R. I.

Magnet and Weather Proof Wires
TROLLEY WIRE
THE MAGNET WIRE CO.
80 William St., New York

THE NATIONAL CONDUIT & CABLE CO.
Manufacturers of BARE COPPER WIRE AND CABLE,
PAPER INSULATED CABLES FOR TELEPHONE, TELEGRAPH, ELECTRIC LIGHT AND POWER.
CEMENT LINED PIPE FOR CONDUITS.
Executive Offices, Times Building, NEW YORK, N. Y.

THE CUTTER CO.
Philadelphia
Circuit Breaker Engineers
Sole Agents for KEYSTONE MEASURING INSTRUMENTS
I-T-E Circuit Breakers

WARREN ELECTRIC AND SPECIALTY CO., WARREN, O., U.S.A. Manufacturers
—ALL KINDS OF—
INCANDESCENT LAMPS
INCLUDING MINIATURES

MONTAUK FIRE DETECTING WIRE CO.
Only Fire Detective Wire in the World. 100 BROADWAY, NEW YORK CITY.
"Approved by the New York Board of Fire Underwriters, February 20, 1901."

AMERICAN ELECTRICAL WORKS
BARE and INSULATED ELECTRIC WIRE
MAIN OFFICE AND FACTORIES - PHILLIPSDALE, R. I.

STANDARD UNDERGROUND CABLE CO.,
FIBER PAPER RUBBER ELECTRIC CABLES, FOR ALL CLASSES OF SERVICE
HIGH-GRADE BARE RUBBER COVERED AND WEATHERPROOF WIRES. Telephone, Telegraph, Electric Light and Power.
Westinghouse Bldg., Pittsburgh, Pa.; 56 Liberty St., New York; 1235 Bets Bldg., Philadelphia, Pa.; 322 The Rookery, Chicago, Ill.; Mills Bldg., San Francisco, Cal.; 10 Post Office Square, Boston, Mass.

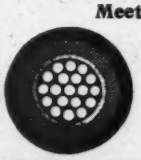
ALL OUR WIRES—NEW CODE STANDARD
NEW YORK INSULATED WIRE COMPANY
Main Office: 114, 116 and 118 Liberty St., New York Branches: CHICAGO, 102 Desplaines St.; BOSTON, 7 Otis St.; SAN FRANCISCO, 38 Second St.

THOUSANDS IN USE
Bipolar and Multipolar Motors from 1-3 to 50 H.-P. Dynamos from 10 lights to 700. We sell or rent. Good profits for Agents.
THE HOBART ELEC. MFG. CO. TROY, OHIO.

25 per cent. Higher Voltage. Visible Action. Integral elements. Greatest durability.
THE U. S. BATTERY CO.
NEW ROCHELLE, N. Y.
Manufacturers of STORAGE BATTERIES FOR ALL ELECTRIC PURPOSES.
Send for catalog "B."

FLEXDUCT
THE SUPERIOR FLEXIBLE CONDUIT FOR INTERIOR WIRING
OSBURN FLEXIBLE CONDUIT CO.
21 PARK ROW NEW YORK CITY

Stanley Electric
THE S C SYSTEM
Manufacturing Co.

Bishop Wires and Cables
Meeting the most trying conditions a specialty

All kinds of FLEXIBLE CABLES. For Controlling, for Electric Lights, and for Annunciators in ELEVATORS
Also for Theatre and other trying work
BISHOP GUTTA-PERCHA COMPANY
422-426 EAST 25TH ST., NEW YORK

SIMPLEX WIRES & CABLES
For Underground, Submarine, Line and Inside Construction
THE SIMPLEX ELECTRICAL CO.
110 State St. BOSTON 1137 Monadnock Blk. CHICAGO

Announcement

The Westinghouse Air-Brake Company

call attention to the fact that only one-seventh of the electric power used by any other system is needed for operating their new system of Electric Train Control.

The weight of this new Westinghouse apparatus, for a car equipped with two 200 h.-p. motors, is nearly **one ton less** than that of any other system.

The extreme simplicity and reliability of this new Multiple Unit Control attract the immediate attention of the men who pay for apparatus for driving electric trains, of the men who install it, and the men who operate it.

The Westinghouse Automatic Coupler couples, in one instantaneous operation, the drawheads of the cars, the air-brake hose, the lighting and heating connections, and the connections of the Multiple Unit Control.

Railway men are invited to inspect these new Westinghouse inventions at the works at Pittsburg

More Light

IN

ALL DIRECTIONS

IS

WHAT YOU WANT

AND

COLUMBIA LAMPS

GIVE

MORE THAN ANY OTHER

Lamps Shipped from Chicago Stock

OKONITE IT NEVER DISAPPOINTS

Central Electric Company,

GENERAL SALES AGENTS

264-266-268-270 FIFTH AVENUE, CHICAGO

OKONITE IT NEVER DISAPPOINTS

D. & W.

Type C indicating fuse before blowing.

Type C indicating fuse after blowing.

BULL'S-EYE INDICATOR

An absolutely FLASHLESS device indicating the blown fuse instantly

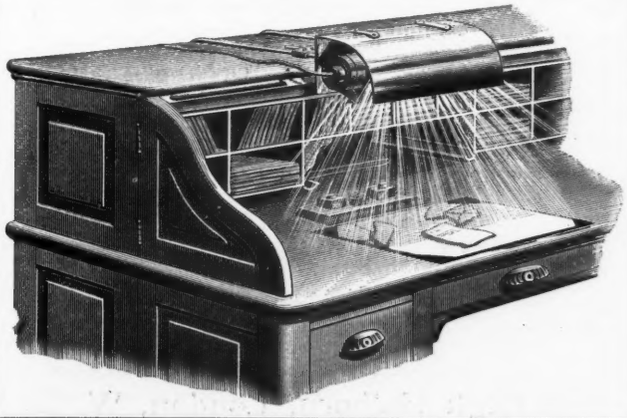
Watch the "TARGET" on the label of the fuse

D. & W. FUSE COMPANY, PROVIDENCE, R. I.

A. HALL BERRY, NEW YORK REPRESENTATIVE, 92 WILLIAM STREET.

OFFICES

BOSTON	NEW YORK	PHILADELPHIA	CHICAGO	ST. LOUIS	SAN FRANCISCO
Pettingell-Andrews Co.	Western Electric Co.	Western Electric Co.	Central Electric Co.	Western Electric Co.	California Electrical Works



Kinsman Daylight Desk Lamp

If the advantages of the Daylight Desk Lamp are not clear to you from the cut, the light from one will show that there is no other desk lamp on the market that can compare with it for lighting up the whole desk interior. Unusually large range of adjustability. A nickel-plated beauty and a winner. Price, $24.00 a dozen. If your Supply Dealer does not handle it send $2.00 for a sample.

Kinsman Electric and Railway Supply Company

91 Liberty Street, New York

The Name "Bunnell"

On Telegraph or Other Electrical Apparatus is Positive Assurance that it is the Best. We are the PIONEER Manufacturers

... DRY BATTERIES ...

Try a Sample Order "Mascot" or "Jove" Dry Cells.

Our NEW JAPANNED and NICKEL-PLATED
"BEEKO" BOX BELLS
Are ABOVE all Others in Quality and Appearance
Below all Others in Price
OUR SUNSHINE LAMPS
ARE WINNERS
They are Brilliant and Long-Lived
WRITE US

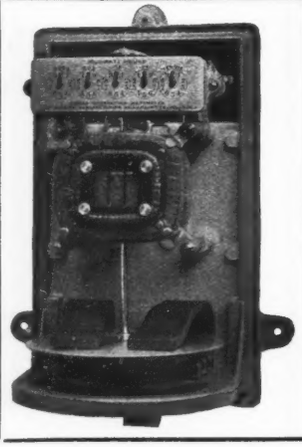
We can Supply Your Wants for
CABLES
WIRES
INSULATORS
And all Electrical Supplies
Best Goods at Lowest Prices
SEE US

J. H. Bunnell & Company

Manufacturers, Importers and Dealers in Telegraph, Telephone, Railway and Electric Lighting Supplies, Instruments, Batteries, Insulated Wires and Line Equipment

20 Park Place, New York. P. O. Box 1286

FACTORIES: 5 to 15 Sullivan Street, 110 to 120 Beekman Street, New York, and Milford, Conn.



Duncan Integrating Wattmeter

FOR DIRECT-CURRENT LIGHTING
AND POWER SERVICE

The Most Accurate and Up-To-Date Meter upon the Market

DUST PROOF NO CONSTANTS SENSITIVE GOOD MAGNETS

Send for Descriptive Bulletin

Duncan Electric Manufacturing Co.

EASTERN AND SOUTHEASTERN AGENTS
Electrical Material Co., Baltimore, Md.

Lafayette, Indiana

SCIENCE ABSTRACTS PHYSICS AND ELECTRICAL ENGINEERING

PUBLISHED MONTHLY

Issued under the direction of the INSTITUTION OF ELECTRICAL ENGINEERS and the PHYSICAL SOCIETY OF LONDON

In two sections: 1. Physics; 2. Electrical Engineering. Subscription, Parts, I. or II., 18/-, post free, each. Both parts, 30/-, post free. Specimen single part, 1/6. Both parts, 2/6.
Guaranteed circulation, over 5,000 copies monthly.

ADVERTISEMENT RATES ON APPLICATION

Address the Publishers

FEILDEN PUBLISHING CO., LTD., = 104 High Holborn, London, W. C.

The New England Engineering Company

Designs, Constructs and Reconstructs ELECTRIC RAILWAYS, ELECTRIC LIGHT and POWER PLANTS, GAS and WATERWORKS.

We have for sale—one 75-Kw., Two-Phase Westinghouse Belt-Driven Generator with Field Rheostat and Base. Has been in use but three months.

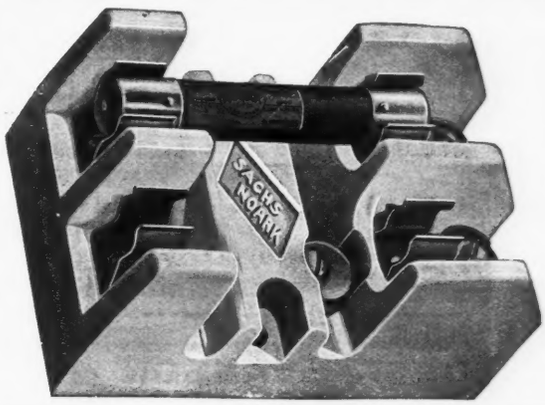
One Single-Phase Wagner Self-Starting Motor, Type A. C. 3½, Frequency 60 Cycles, Horse-Power 7½, Volts 208. R. P. M. 1300.

Anyone wishing a bargain in this apparatus will receive same by applying to New York Office.

100 Broadway, N. Y.
and Waterbury, Ct.

Branch Offices in Hartford, New Britain, New London, Branford, New Haven, Stamford and Greenwich, Ct., and Larchmont, N. Y.

"Noark" Branch Fuse Blocks



Single Branch
Two Pole and
Three Pole

Maximum Space Economy
Ease of Installation
Safety in Operation

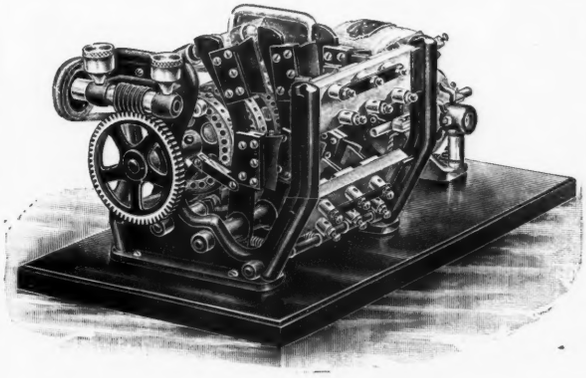
The main wires to which the branch block is connected, instead of passing across the block at the end of the branch fuses, are arranged to traverse it in suitable grooves placed in the porcelain block between the terminals of the branch fuses, resulting in economy of space and ease and safety in manipulating fuses.

Send for Complete Set of "Noark" Fuse Bulletins

NEW YORK
MILWAUKEE
CHICAGO
ST. LOUIS
BOSTON

H. W. JOHNS-MANVILLE CO
100 WILLIAM ST. NEW YORK

PHILADELPHIA
CLEVELAND
PITTSBURG
NEW ORLEANS
LONDON



WRITE FOR

Bulletins on our Flashes and Time Switches

ELECTRIC SIGNS

Our signs bear the stamp of originality

The Electric Motor and Equipment Co.

Newark, N. J.

DON'T WAIT TILL FALL

To buy transformers when all want them at the same time. Order now for future delivery. For Life, Regulation on Inductive and Non-Inductive Loads, and 2 and 3-Wire Distribution, Efficiency and Temperature Rise, our Type "M" Transformers have no superior. A trial will convince you as it has others. Let us know your requirements.

WAGNER ELECTRIC MFG. CO.

ST. LOUIS, MO., U. S. A.

PULLEN CELLS

for operating

BATTERY FANS

2 volts each Cell

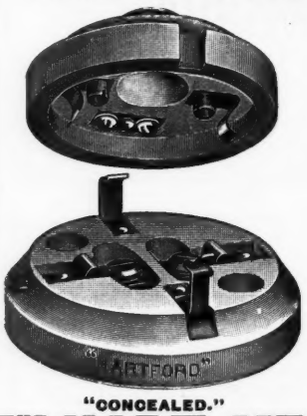
LONG LIFE

SEND FOR CIRCULAR AND PRICES

LEON W. PULLEN ELEC. COMPANY

16 Chestnut Street, Philadelphia

"HARTFORD" ROSETTES



FOR CLEAT, CONCEALED AND MOULDING WORK.

Approved by the UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION.

Cap and bases interchangeable.

Positive lock and sure contact.

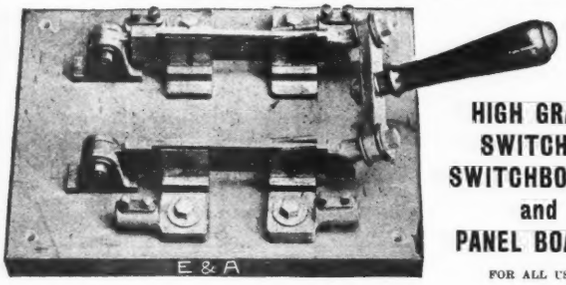
Cap can not be loosened or contact lessened by shaking or pulling on the cord.

"CONCEALED."

THE HART MFG. CO., HARTFORD, CONN.....

GEORGE T. EYANSON & CO.

15 N Seventh Street, Philadelphia, Pa.



Manufacturer of

HIGH GRADE SWITCHES SWITCHBOARDS and PANEL BOARDS

FOR ALL USES

New York Representative, J. GOODMAN & CO., 23 Duane Street

Micabeston IS THE BEST INSULATOR **for Commutators**

Imperial Varnish Cloth IS THE BEST INSULATOR **for Armatures**

SILLS-EDDY MICA COMPANY

CHICAGO NEW YORK

New York Agents General Electric Co.'s Edison Lamps

Stanley & Patterson

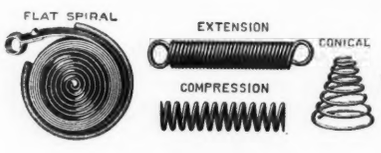
(Incorporated)

Manufacturers of

General Electrical Equipment Supplies

93 Liberty Street, New York

Uptown—329 Fourth Avenue—Store



Cary Spring Works

240 & 242 West 29th St. NEW YORK CITY

Manufacturers of

Wire and Springs

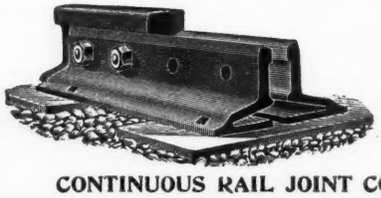
For Machinery, Motors, Clocks, Music Boxes and all kinds of Electrical Purposes

CARBONS

CONSUMERS CARBON CO.

LANCASTER, OHIO, U. S. A.

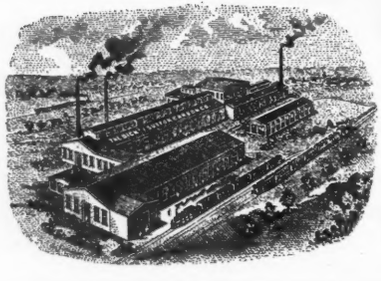
Carbons of all kinds and for all purposes.



Over Fifteen Thousand Miles in Use

CONTINUOUS RAIL JOINT CO. of AMERICA

General Offices: Century Building Newark, N. J.



CARBONS

THE DICKEY-SUTTON CARBON COMPANY

LANCASTER, O.

WE MANUFACTURE ELECTRIC LIGHT CARBONS OF ALL KINDS, DRY BATTERIES AND BATTERY CARBONS, CARBON BRUSHES AND SPECIALTIES, ELECTROLYTIC CARBONS

WHEN Writing for Catalogues, Information or Prices, YOU WILL CONFER A FAVOR on both the ADVERTISER and the PUBLISHER by mentioning the fact that you saw the advertisement in the ELECTRICAL REVIEW.

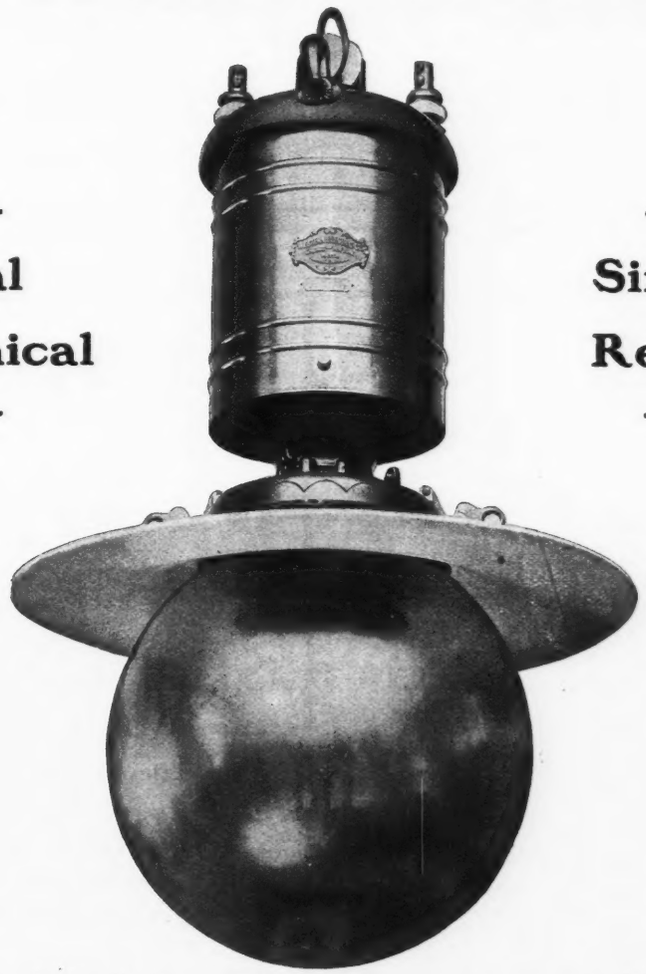
Western Electric Company

Chicago—Saint Louis—Denver—Philadelphia—New York

SERIES ALTERNATING ARC LIGHTING SYSTEM

Practical
Economical

Simple
Reliable



The Standard for Efficiency and Long Life

Underground Transmission without Conduits or Lead Encased Cables.

THE ONLY ABSOLUTELY PERFECT SYSTEM OF ELECTRICAL TRANSMISSION FOR ALL VOLTAGES UP TO 150,000.

Perfect Safety. Low Cost. Permanence. No Expenditure for Maintenance. In Use 5 Years without a Cent for Repairs.
Not Affected by Change of Temperature, or Climatic Conditions.
We Will Execute Contracts of Any Dimensions.
Telephone, Telegraph, Railway or Power.
Write Us Before Concluding Your Plans.

HUNGERFORD ELECTRIC & MANUFACTURING COMPANY

Offices—25 BROAD STREET, NEW YORK **Factories—BELLEVILLE, N. J.**

HABIRSHAW WIRES

were used throughout the

STUDEBAKER BUILDING
NEW YORK

The Installation was done by

HARRY ALEXANDER
Electrical Engineer & Contractor
25 West 33d Street, New York

The India Rubber and Gutta Percha Insulating Co.

SALES OFFICE, . . 15 CORTLANDT ST., N. Y.
OFFICE and FACTORY, . . . YONKERS, N. Y.

The time to think hardest about insulating varnish is when you are buying a new machine.

You can have it insulated with ARMALAC or you can have it saturated with a life-shortening compound composed of linseed oil and called "varnish" or "japan."

The temporarily high resistance is supposed or claimed to equal the permanent insulation of ARMALAC.

Any purchasing agent's attention can be profitably directed to our line of insulating tapes and splicing compounds.

Address all inquiries "INSULATION DEPT."

Massachusetts Chemical Co.

170 Summer Street, BOSTON, MASS., U.S.A.

Insulation Plant and Rubber Works, Walpole, Mass.

Authorized Agencies carrying Stock of Genuine Goods:

W. R. GARTON CO.
118 Jackson Boulevard, CHICAGO, ILL.

ELECTRIC, RAILWAY & MFRS. SUPPLY CO.
68-72 First St., SAN FRANCISCO, CAL.

CONSUMERS' RUBBER CO.
199 Bank St., CLEVELAND, O.

CARTER & GILLESPIE ELECTRIC CO.
40 North Broad St.
ATLANTA, GA.

J. H. ASHBY
Hennen Building
NEW ORLEANS, LA.

AMERICAN GENERAL TRADING CO.
136 Liberty St. and 139 Cedar St.
NEW YORK

JAS. CLARK, Jr. & CO.
315 West Main St.
LOUISVILLE, KY.

F. J. DOWN
Harpenden, Herts, ENGLAND

PHILIPP MUHSAM
Alexandrinenstrasse 11, BERLIN, GERMANY

PERSICANER & CO.
VIENNA and BUDAPEST

VICTOR DOURIN
28 Rue de la Montagne, BRUSSELS

American Steel & Wire Co.

Chicago New York Worcester Denver San Francisco

BARE AND INSULATED

ELECTRICAL WIRES

WACLARK WIRE CO

COPPER WIRE

NEW YORK CHICAGO
PHILADELPHIA ELIZABETH, N.J.

NATIONAL ELECTRICAL CODE STANDARD

IXL
Weather-Proof
Slow Burning Weather-Proof
Slow Burning Wire

PRICES AND SAMPLES ON APPLICATION

COLLYER INSULATED WIRE AND CABLE CO. PAWTUCKET R. I.

HAZARD MANUFACTURING CO., WILKESBARRE PA.

HIGH-GRADE RUBBER-COVERED WEATHERPROOF **WIRES and CABLES.**

Magnet, Office, Annunciator Wire.

NEW YORK OFFICE, 50 DEY STREET. CHICAGO OFFICE, 1201 MARQUETTE BUILDING.

WHEN ANSWERING ADVERTISERS PLEASE MENTION THIS PAPER.

HABIRSHAW WIRES AND CABLES

The India Rubber and Gutta-Percha Insulating Co.

SALES OFFICE, 15 CORTLANDT ST., NEW YORK

OFFICE AND FACTORY, GLENWOOD WORKS, YONKERS, N. Y.

RUBBER COVERED WIRES & CABLES

For Every Service

For Underground, Aerial and Submarine use, "SAFETY" wires and cables have the endorsement of some of the largest users in the United States.

The Safety Insulated Wire & Cable Co.

114-116 LIBERTY ST., NEW YORK

H. N. FENNER, President J. F. BLAUVELT, Agent RUSSELL W. KNIGHT, Treasurer

NEW ENGLAND BUTT COMPANY

Manufacturers of

MACHINERY FOR INSULATING ELECTRICAL WIRES

Braiding, Taping, Winding, Twinning, Cabling, Stranding, Polishing and Measuring Machines. Cable Covering Braiders

FINE CASTINGS A SPECIALTY

304 PEARL STREET, - - - - PROVIDENCE, R. I., U. S. A.

ON THE PACIFIC COAST . . .

"I saw three copies of the **ELECTRICAL REVIEW**," said a salesman who calls on the electric lighting industry, "to one of any other electrical journal. Our advertisement in the **ELECTRICAL REVIEW** aided me in my work as they knew us through it before I called on them."

FLEXIBLE CONDUIT

When ordering Flexible Conduit be sure and specify

"CIRCULAR LOOM"

and you will get the best Flexible Conduit procurable

REMEMBER!!! "CIRCULAR LOOM"

THE ORIGINAL CONDUIT

American Circular Loom Co.

CHELSEA, MASS.

SAN FRANCISCO : : : JOHN R. COLE, 33 Second Street
NEW YORK : : : : R. B. COREY, 26 Cortlandt Street
CHICAGO : : THOS. S. GRIER, 128 W. Jackson Boulevard

Four Special Reasons Why You Should Specify Okonite Products

TRADE MARK

The Standard for Rubber Insulation

I. Quality of Materials.

Years of Manufacture and Tests have Proven What is the Best Grade and kind of Materials for the Manufacture of Rubber Insulation.···· Our Constant Care that Only this **Best** Grade shall enter into Okonite Products have Made them the **Standard** - the Best.···· Knowing that the Best is and Will Be Admitted to be, the Cheapest, in the End, we have failed to See Any Inducement in Cheapening Our·· Product, by Using Poor Materials, to Compete for the Trade of the Man Who Learns only By his own Bitter Experience.

The Okonite Company, Ltd.

253 Broadway, New York

Willard L. Candee
H. Durant Cheever
} Managers

ELECTRICAL REVIEW.

Four Special Reasons Why You Should Specify Okonite Products

TRADE MARK

The Standard for Rubber Insulation

II. Superiority of Manufacture

Experience Proves that to Secure Perfect Insulation, Uniformity Must Be Preserved. ··· Therefore We Eliminate Every Possible Chance of a Weak Spot Occurring in Our Product. ··· We do More. We employ Careful, Expert Inspectors, who Examine Every Piece of Goods Made in Our Factory. ·· Only Perfect Goods can reach You. ··· When you buy Okonite Products, you Safeguard Your own Interest by Securing Goods to be Depended on.

The Okonite Company, Ltd.

253 Broadway, New York

Willard L. Candee, H. Durant Cheever } Managers

ELECTRICAL REVIEW.

Four Special Reasons Why You Should Specify Okonite Products

TRADE MARK

The Standard for Rubber Insulation

III. Longevity

Durability is a Point on which We lay Special Stress. Next to Perfect Insulation, It is the Most Important.. ··· The High Quality of the Materials We Use·· and Our Methods of Manufacture, Both assist in Making our Goods Durable, but there's a Knowledge, a Science all our Own, which Prescribes a Life-giving Ingredient, Peculiar to OKONITE, securing Longer Service and Placing OKONITE Products Ahead of All Others in Economy's Scale··· The Best, the Cheapest in the End.

The Okonite Company, Ltd.

253 Broadway, New York

Willard L. Candee, H. Durant Cheever } Managers

ELECTRICAL REVIEW

Four Special Reasons Why You Should Specify Okonite Products

TRADE MARK

The Standard for Rubber Insulation

IIII. Amphibiousness

Perfect Rubber Insulation Must be Adapted to All Conditions. ... The Certainty that OKONITE Products will Prove the BEST Under Every Condition, is Responsible for the "Okonite" Idea being Foremost in the Specifications of Leading Engineers. ... Can You Afford to be Less Particular? ..

Prices and further information cheerfully furnished.

The Okonite Company, Ltd.

253 Broadway, New York

Willard L. Candee
H. Durant Cheever } Managers

ELECTRICAL REVIEW

KERITE

Wires and Cables

SUBMARINE, AERIAL

UNDERGROUND

ONLY MEDALS
OF AWARD FOR HIGH-GRADE
INSULATION

BOTH FOR
WIRES AND CABLES, WORLD'S
FAIR, 1893

. . . . FOR . . . .

Telegraph, Telephone, Electric Light and Electric Railways

Makers of Government Military Cables for Alaska and the Philippine Islands
Standard for Nearly Forty Years

Kerite Tape, Rubber Tape, Elastic Tape

W. R. BRIXEY, Manufacturer

203 Broadway, New York, U. S. A.

H. G. MADDEN, Agent

FOSTORIA
INNER GLOBES

You aim to be very particular in the selection of arc lamps, generators, etc., making cost a secondary consideration, because it is a case of a permanent investment. This is as it should be.

DO NOT HANDICAP A HIGH PRICED, HIGH GRADE INSTALLATION WITH POOR RENEWALS.

Write us for further information and our New Price List of April, 1903.

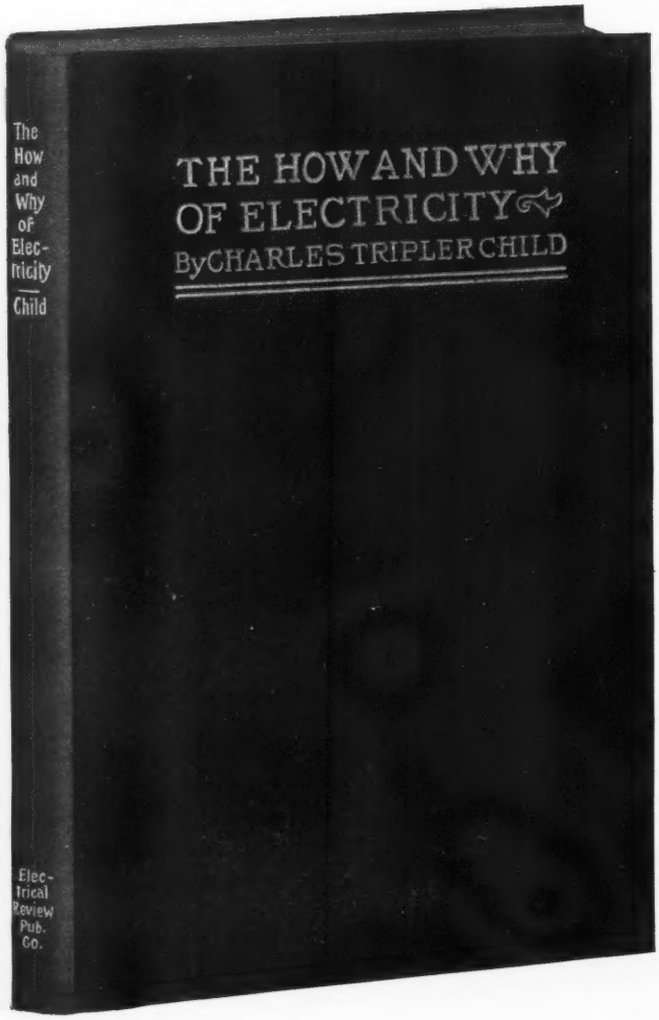
The Fostoria Incandescent Lamp Co.

FOSTORIA OHIO

"The How and Why of Electricity"

By CHARLES TRIPLER CHILD, Late Technical Editor of the Electrical Review

PRICE $1.00, POSTAGE PREPAID



CONTENTS

CHAPTER

Preface.
I The Electric Current.
II The Electric Battery.
III The Effects of Electric Flow in the Circuit—Heat and Chemical Action.
IV The Effects of Electric Flow Outside the Circuit—Magnetism and Induction—The Electrical Units.
V Electromagnets—The Telegraph.
VI Electric Signaling Apparatus.
VII The Relations Between Magnets and Electric Currents.
VIII Induction and Reactive Coils.
IX The Telephone.
X Telephone Accessories.
XI The Mechanical Generation of Electricity.
XII The Dynamo Machine.
XIII Various Types of Dynamo Machines.
XIV Alternators—Polyphase Currents.
XV The Electric Motor.
XVI The Electric Railway.
XVII Polyphase Currents and Motors.
XVIII Electrical Power Transmission.
XIX The Incandescent Light.
XX The Arc Light.
XXI Electrochemistry—Storage Batteries.
XXII Wireless Telegraphy.
XXIII Radiation—X-Rays.

"The descriptions are helped out with cuts and diagrams that really explain. We know nothing that gives so much help on a difficult and complex matter in so short a space."—*New York Sun, December 27, 1902.*

"Is admirably adapted to instruct the non-technical reader who is interested in that subject. * * * Mr. Child enjoyed a high reputation for the clearness and intelligibility of his writing, and the volume in question exhibits these qualities."—*New York Tribune, December 26, 1902.*

"We can unhesitatingly recommend this book to all non-technical readers, who desire a simple and yet correct account of the different features of modern electrical development."—*Street Railway Journal, New York, January 10, 1903.*

"An excellent manual of the uses of electricity, and while not intended in any way as a text-book, the work is of much value to readers, both professional and lay."—*National Electrical Contractor.*

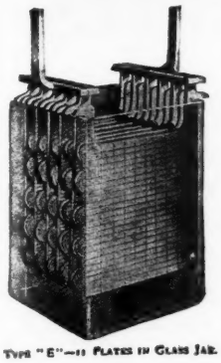
"Mr. Child has left a good book; one that we can heartily commend to the non-technical readers for whom it was written; they will not be led astray by platitudinous nonsense, but will receive solid, exact information, if simply expressed."—*Western Electrician, Chicago, February, 21, 1903.*

"The book is a handy one; just what nine men in ten demand in order to seize rapidly the practical side of electricity."—*San Francisco Chronicle, February 7, 1903.*

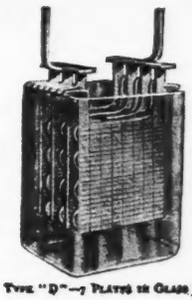
"In spite of the great mass of electrical literature already existing, it is one of the first good books of its kind. * * * It will find a large circle of readers on its evident merits."—*Engineering News, New York, February 19, 1903.*

Address **ELECTRICAL REVIEW**

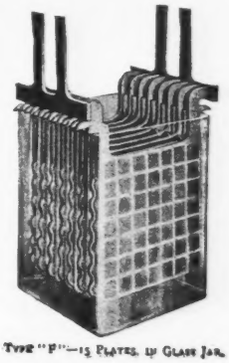
BOOK DEPARTMENT **13 PARK ROW, NEW YORK**



TYPE "E"—11 PLATES IN GLASS JAR.



TYPE "D"—7 PLATES IN GLASS JAR.



TYPE "F"—15 PLATES, IN GLASS JAR.

THE "Chloride Accumulator"

TYPE "B" 5 PLATES, IN GLASS JAR.

INSTALLATIONS MADE AND CONTRACTED FOR.

TYPE "C" 3 PLATES, IN GLASS JAR.

FOR CENTRAL LIGHTING & POWER STATIONS

86 Installations aggregating 116,500 Kilo Watt Hours

FOR RAILWAY SERVICE

272 Installations aggregating 158,100 Kilo Watt Hours

TYPE 501—PORTABLE BATTERY

FOR ISOLATED LIGHTING & POWER

501 Installations aggregating 25,200 Kilo Watt Hours

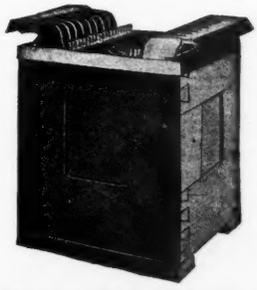
Total Capacity of "Chloride Accumulators" in Central Station, Railway and Isolated Plant Service, 305,111 Kilo Watt Hours

TYPE 504—PORTABLE BATTERY,

THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA, - PA.

SALES OFFICES



TYPE "G"—19 PLATES, IN LEAD-LINED TANK.

PHILADELPHIA
Allegheny Avenue & 19th Street

NEW YORK
100 Broadway

BOSTON
60 State Street

BALTIMORE
Continental Trust Building

S. T.—COUPLED, IN GLASS JARS.

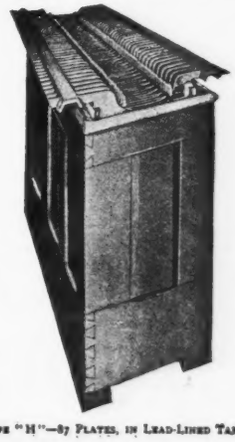
CHICAGO
Marquette Building

CLEVELAND
Citizens Building

ST. LOUIS
Wainwright Bldg.

SAN FRANCISCO
Nevada Block

HAVANA, CUBA
34 Empedrado Street



TYPE "H"—87 PLATES, IN LEAD-LINED TANK.

NATIONAL STORAGE BATTERIES

OF HIGHEST GRADE FOR

RAILWAY POWER PLANTS, CENTRAL STATIONS, AUTOMOBILES, ETC.

RENEWALS FOR BATTERIES OF ANY MAKE

DETAILS ON APPLICATION

NATIONAL BATTERY COMPANY

368-382 MASSACHUSETTS AVENUE, BUFFALO, N. Y.

THE REUTERDAHL STORAGE BATTERY

OUR

Electrochemically Formed Plate

IS CONSTRUCTED IN ACCORDANCE WITH THE MOST ADVANCED IDEAS OF MODERN ELECTROCHEMISTRY

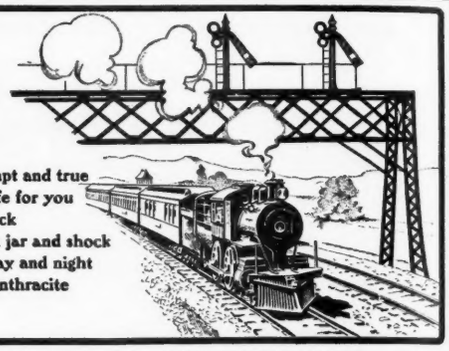
WRITE FOR BULLETIN G

REUTERDAHL ELECTRIC CO. PROVIDENCE R.I.

WESTERN OFFICE. 1504 MONADNOCK BLOCK. CHICAGO ILL.

Lackawanna Railroad

THIS IS THE ROAD OF ANTHRACITE.



These are the signals prompt and true
That make the journey safe for you
Over the bed of ballast rock
That keeps the trains from jar and shock
That smoothly run both day and night
On the dustless Road of Anthracite

ALL SIGNALS OPERATED EXCLUSIVELY BY

EDISON PRIMARY BATTERIES

Formerly Known as Edison-Lalande.

FULL DESCRIPTION IN BOOKLET NO 17

EDISON MANUFACTURING COMPANY

Factory, ORANGE, NEW JERSEY, U. S. A. New York Office, 83 CHAMBERS STREET

Chicago Office, 304 WABASH AVENUE

SHELBY LAMPS SHELBY, OHIO.

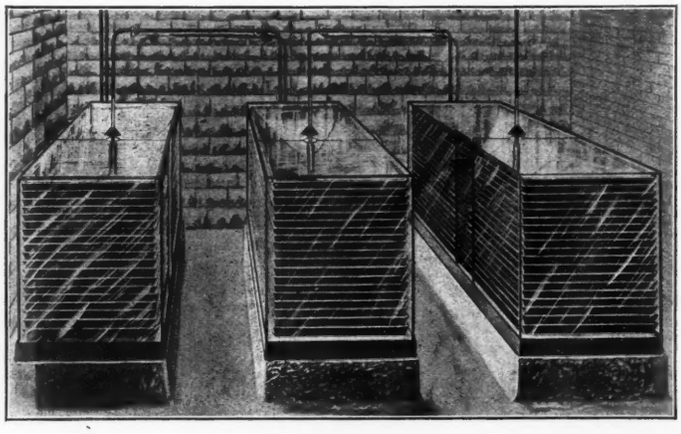
WHEN ADDRESSING ADVERTISERS PLEASE MENTION THIS PAPER.

SMITH TRAY PLATE STORAGE BATTERY SYSTEM

Installation in the HOTEL CARLTON, BOSTON, MASS.

Consisting of 57 Trays with a capacity of 800 ampere hours at 114 volts.

Accessibility for inspection
Compactness
Protection from dirt
READY RESPONSE TO ALL VARIATIONS OF LOAD



The TRAY system of the Smith Storage Battery has many other advantages over the usual type. Write us for information.

REMOVAL

On account of increased business we have found it necessary to move into a larger factory and wish to announce that we are now located at 5 to 11 Frederick and 504-512 State Streets.

SMITH STORAGE BATTERY CO., Binghamton, N. Y.

Gould Storage Battery Co.

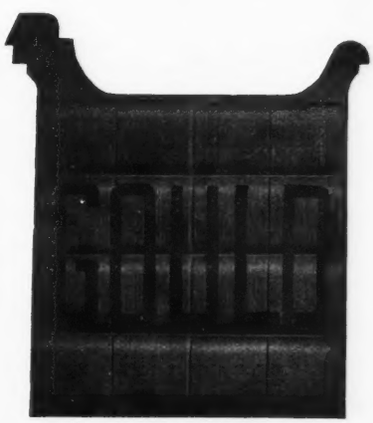
NEW YORK

Manufacture and Install

CENTRAL STATION EQUIPMENT

of any size for

LIGHTING AND POWER



TRADE MARK

BULLETINS ON APPLICATION

SALES OFFICES

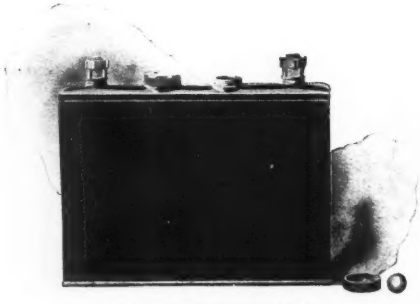
BOSTON, 53 STATE ST. CHICAGO, ROOKERY BLDG. NEW YORK, 25 W. 33D ST.
CENTURY ELECTRIC COMPANY, SAN FRANCISCO, CAL.
PITTSBURG ENGINEERING COMPANY, PITTSBURG, PA.

WORKS: DEPEW, N. Y.

APPLE

STORAGE BATTERIES

Non-breakable, entirely sealed, being practically a lead bottle.



4-Volt Storage Battery

Originally designed for ignition purposes, we are now building batteries on this principle for all purposes.

GAS ENGINE IGNITERS

Apple Dynamo Igniter No. 62B, with door open

Apple Type A Igniting Outfit

Apple Magneto Igniter, door closed

Apple Magneto, door open

We make a full line of ignition material.

A number of the largest electrical supply houses have taken hold of our line and are doing a profitable business. Why should you not do likewise.

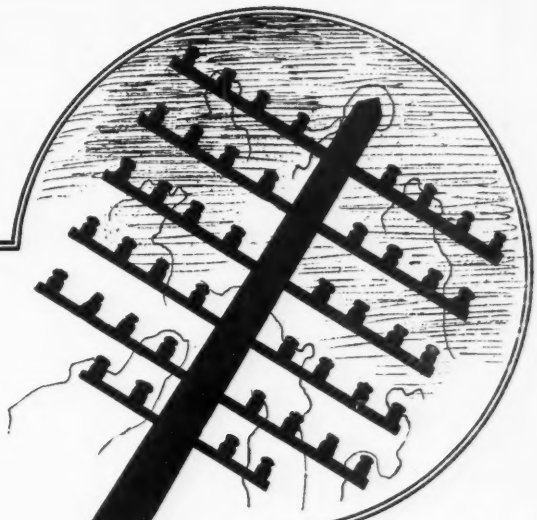
WRITE FOR CATALOGUE No. 10

The Dayton Electrical Mfg. Co.

No. 3 S. St. Clair Street

Dayton, = = Ohio, U. S. A.

CONDUIT



THE UNSIGHTLY
AND EXPENSIVE
POLES
MUST
GO.....

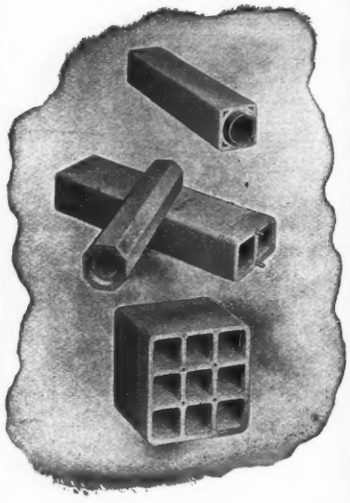
COMPLETE
SUBWAY SYSTEMS
BUILT FOR ALL PURPOSES

ESTIMATES,
SPECIFICATIONS, DESIGNS
AND PLANS FURNISHED

G. M. GEST
Expert Subway Contractor

Broadway Chambers Building,
277 BROADWAY, NEW YORK.
Union Trust Building, CINCINNATI, OHIO.

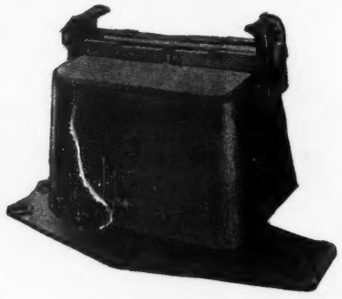
SYSTEMS



American Vitrified Conduit Co.

GENERAL OFFICE — Broadway-Maiden Lane Building, NEW YORK

Manufacturers of **VITRIFIED GLAZED CONDUIT**



MANHATTAN THIRD-RAIL INSULATOR

40,000 of this type Insulator furnished by us to Manhattan Railway Co. of New York

Look for this Trademark

On Flexible Conduits

FLEXIBLE TRADE EUREKA MARK CONDUIT

IT SIGNIFIES QUALITY

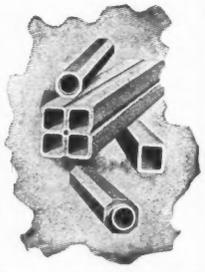
— The —

Rittenhouse-Miller Co.

923 Witherspoon Bldg.

Philadelphia

Vitrified Clay Conduits



MULTIPLE SINGLE

LARGE FACTORIES, MODERATE PRICES PROMPT DELIVERIES

Sole Sales Agent for Factories. Expert Engineers. Contracts for Conduits or Complete Subway Systems. The largest and most difficult contracts undertaken.

C. J. FIELD

Field Conduit Contracting Co.

29 Broadway, New York

WILLIAM E. BENSON & COMPANY

Manufacturers of the "EL-BEND" for bending electric conduit. List price, $30.00. Machines in stock in principal cities of the United States and Canada.

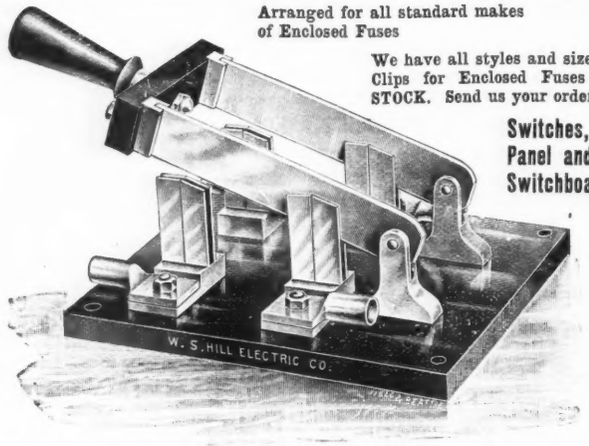
GENERAL OFFICES, 1001-13 CHESTNUT ST. PHILADELPHIA, PA.

KNIFE SWITCHES

Arranged for all standard makes of Enclosed Fuses

We have all styles and sizes of Clips for Enclosed Fuses IN STOCK. Send us your order for

Switches, Panel and Switchboards



W. S. HILL ELECTRIC COMPANY

NEW BEDFORD, MASS.

20 Per Cent Gain

in advertising for the first quarter of 1903 over the same quarter of 1902.

30 Per Cent Gain

in subscriptions for the first quarter of 1903 over the same quarter of 1902.

22 Per Cent Gain

in number of editorial pages for the first quarter of 1903 over the same quarter of 1902.

In all these departments, the first quarter of 1902 marked about a similar gain over the same quarter of 1901.

These are some of the figures of the expansion of the ELECTRICAL REVIEW. Such growth, after 22 years of existence, shows a degree of success worthy of notice by advertisers.

Mobile Light and Railroad Co., Mobile, Ala.

Flexibility

The Convenient Length and Practical Construction of the Standard Vitrified Conduit make a Bend or Turn easy.

The External Key Feature

Makes the work sure and keeps the duct forever in its place.

Refinements of Processing

Insure a smooth interior, with no danger of cutting the cable sheath on bad edges.

STANDARD VITRIFIED CONDUIT COMPANY

39-41 Cortlandt Street, New York City

R. W. LYLE, Pres. and Gen. Man. B. S. BARNARD, Vice-Pres and Sec. W. A. SNOW, Treas.

American Conduit Co.

Manufacturers of

Bituminized Fiber Conduit (Patented)

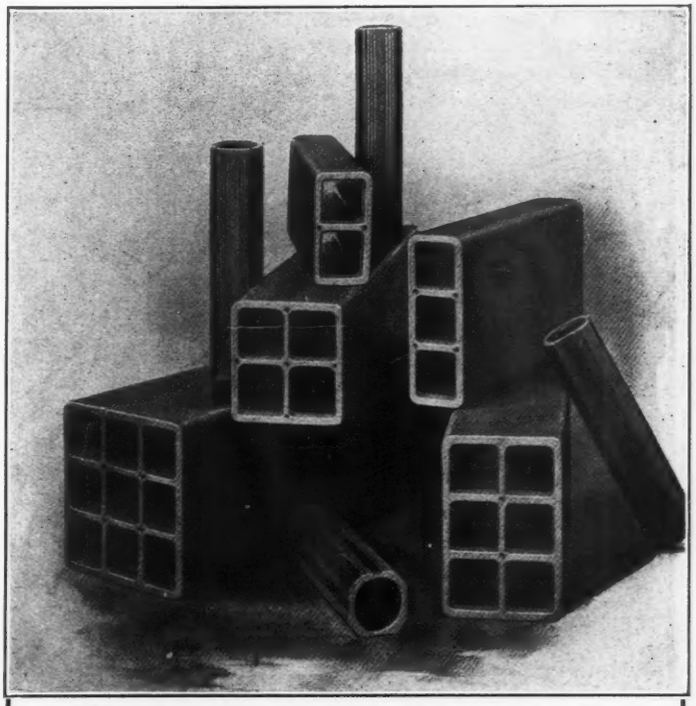
For UNDERGROUND ELECTRICAL WORK

Our Conduit is { ELECTROLYSIS-PROOF, NON-ABRASIVE, MOISTURE-PROOF, NON-CORROSIVE, CHEAPLY and RAPIDLY LAID } Insulation Test 66,000 Volts

We give you a perfect joint, which is self-aligning and makes each duct a continuous tube from manhole to manhole.

It will pay all those interested in subway construction to write us for particulars and prices before closing contracts for Conduit. State sizes and quantity desired.

Offices: 720 Arcade Building, PHILADELPHIA, PA.
822 Manhattan Building, CHICAGO, ILL.
336 Macy St., LOS ANGELES, CAL.
Factories: Chester, Pa., Chicago, Ill., Los Angeles, Cal.



THE H. B. CAMP CO.

170 Broadway, New York 85 Hartford Bldg., Chicago

LARGEST MANUFACTURERS OF

VITRIFIED CLAY CONDUIT

FOR ELECTRIC WIRES

The General Electric Company's

Thomson High-Torque Induction Meter

Has torque of 80 millimetre-grammes at full load. Compare this with the torque of other meters. Losses in field at full load less than one watt. Losses in potential circuit less than two watts.

Total losses at full load in field and potential circuits about 2 1-2 watts.

Torque of 32 millimetre-grammes per watt loss at full load; weigh the importance of this fact.

General Offices: Schenectady, N. Y.

New York Office, 44 Broad Street.

Sales Offices in all large cities.

The General Electric Company's

Portable Torque Balance

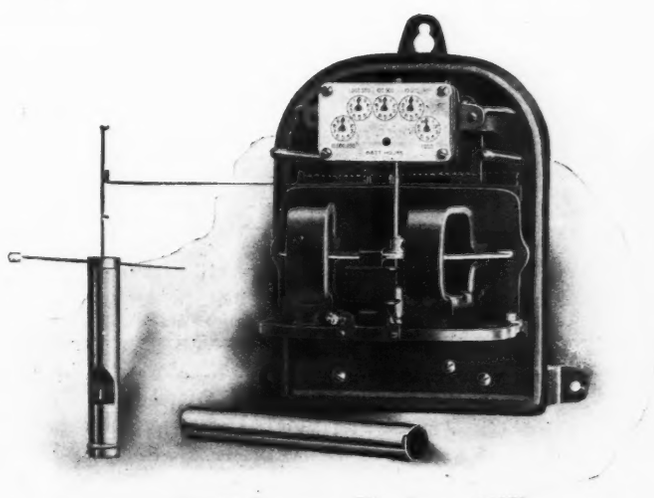
The value of a Meter is determined by its ability to maintain accuracy in use.

PERMANENT ACCURACY DEPENDS UPON TORQUE.

The General Electric Company's Portable Torque Balance will accurately measure the absolute torque of any motor meter.

Measure the torque of the meters you are using and propose to use.

This device will prove invaluable to all Central Stations.



General Offices: Schenectady, N. Y.

New York Office, 44 Broad Street.

Sales Offices in all large cities.

Snap Switches
Indicating Switches
Key Switches
Flush Switches
Gang Plates
Push Button Switches
Art Plates
Door Switches
Baby Knife Switches
Punch Clip Knife Switches
Ed., T. H. & West. Key Sockets
Receptacles
Weatherproof Sockets
Attachment Plugs
Midget Plugs & Receptacles
Rosette Plugs & Receptacles
Flush Plugs & Receptacles
K. W. Cut-Outs
Competition Cut-Outs
Branch & Main Cut-Outs
Dow Adjusters
Gongs
Watchman's Registers

ACCURACY

Parts of the Push Switch are made by Styrian steel tools. They are accurate to 1/1000 of an inch. This is why the switches work so easily and stand severe electrical and mechanical strain. The Push Switches have a reputation not only of being the most economical switch to wire, but the simplest switch, especially in the matter of Face Plates—one kind fits all occasions.

Your use and specification of the will do us both good.

No. 532 Push Button Switch

IF YOU DO NOT RECEIVE OUR REMINDERS, SEND YOUR BUSINESS CARD AND GET THE "CHOICE STUFF" WEEKLY. PLEASE MENTION ELECTRICAL REVIEW.

MARSHALL-SANDERS CO.

BOSTON, MASSACHUSETTS

HART & CO., Monadnock Bldg., Chicago, Ill.

STOP! LISTEN! LOOK AROUND!

Before Contracting for

INCANDESCENT LAMPS

Get the STERLING SPECIAL Literature.

STERLING ELECTRICAL MFG. CO.
Warren, Ohio.

THE SIMPLEST, MOST PRACTICAL AND ECONOMICAL TURN-DOWN ELECTRIC LAMP EVER INVENTED

The ECONOMICAL

Style 1—Pull string for bright or dim. Style 2—For variation in light turn bulb one way or the other. Write for booklet and prices. All voltages and bases.

ECONOMICAL ELECTRIC LAMP CO. 123 LIBERTY STREET NEW YORK

Kilfyre
DRY FOUNDER COMPOUND

IDEAL FIRE PROTECTION FOR ALL ELECTRICAL APPARATUS

Highest Awards at National Export, Central Canadian, Pan-American and Charleston Expositions.

MONARCH FIRE APPLIANCE COMPANY
247-249 Pearl St., NEW YORK CITY

ANY CANDLE POWER

STANDARD ELEC. MFG. CO. STAR NILES OHIO. U.S.A.

ALL VOLTAGES

This Label on incandescent lamps guarantees best quality lamps

STANDARD ELECTRIC MFG. CO., Niles, Ohio

ORIGINAL DESIGNS IN ELECTRIC SIGNS

This ad. is to call your attention to the SUPERIOR ELECTRIC SIGNS which we manufacture from our patent Reflector Letters.
Consumes less current than any sign on the market.
Gives great brilliancy with little cost.

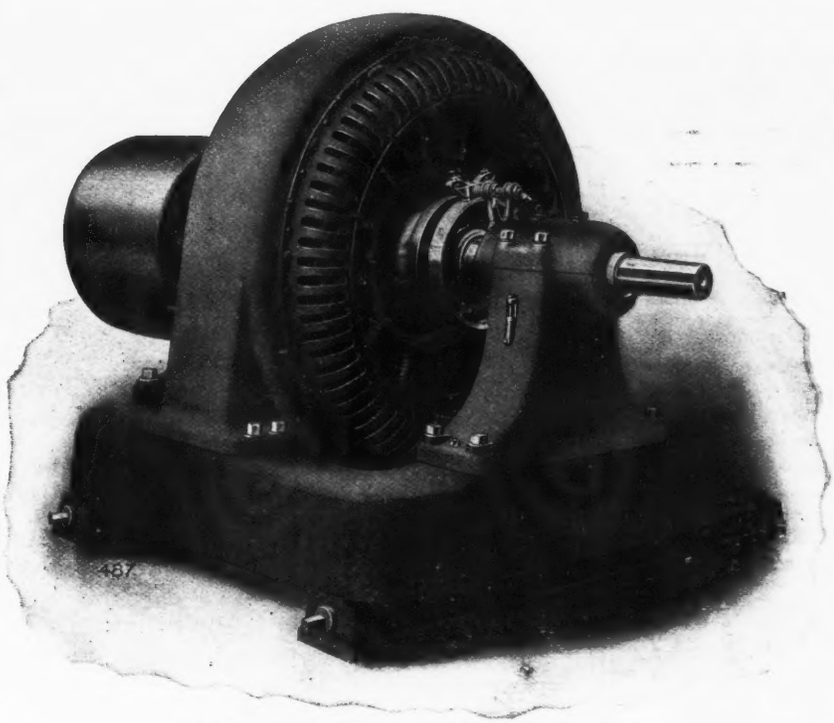
Made from the very best material.
All designs new and original to suit the trade for which they are intended. Write for our catalog. Estimates and prices furnished on application. Special prices to electrical dealers and lighting companies.

PACIFIC ELECTRIC COMPANY, LA CROSSE, WIS., U. S. A.

"CECO" Generators

DIRECT CURRENT
in capacities up to
1000 K.W.

ALTERNATING CURRENT
in capacities up to
1500 K.W.



250 K.W. 3-Phase "Ceco" Alternator

For **Lighting**
Power and
Railway
Service

SOME ADVANTAGES
Modern Design
Accurate Construction
Cool Running
Unequalled Performance

WRITE FOR CATALOGUE 26

Christensen Engineering Company

Chicago: Old Colony Building
Pittsburg: Gellatly & Co.

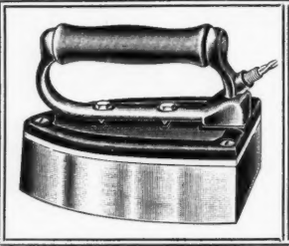
Milwaukee

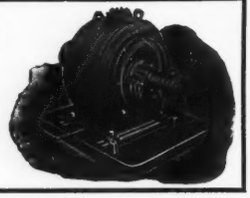
San Francisco
Seattle
} Kilbourne & Clark Co.

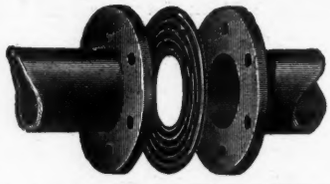
OUR GENERATORS
AND MOTORS
DIRECT-CONNECTED AND BELTED
HAVE BECOME TO BE RECOGNIZED
AS THE
STANDARD
The ELWELL-PARKER ELECTRIC Co.
OF AMERICA
CLEVELAND, OHIO, U.S.A.

MOTORS GENERATORS
AKRON ELECTRICAL MFG. CO. AKRON-O.
OPEN OR ENCLOSED FOR POWER PURPOSES
BELTED OR CONNECTED DIRECT FOR LIGHTING PURPOSES
1 TO 600 HP 1 TO 500 KW

BEST ON THE MARKET
THE NEW ENGLAND MOTOR CO.
LOWELL, MASS.


ELECTRIC IRONS
From 3 to 30 lbs.
SEND FOR CATALOGUE
Manufactured by
American Electrical Heater Co.
Detroit, Mich., U. S. A.

DYNAMOS and MOTORS
Eck Dynamo and Motor Works
Belleville, N. J., U. S. A.
TRADE MARK


Our... Patented Mineral Wool Coverings and Copper Gaskets

THEY SAVE STEAM AND MAKE ABSOLUTELY TIGHT JOINTS
U. S. MINERAL WOOL CO.
106 West St.
NEW YORK - - N. Y.

Oily Waste Cans
Approved by the Board of Underwriters, Required by Fire Insurance Companies.
The cans are made of galvanized iron. Stands on legs four inches from the floor. *The cover is self-closing. Can't be left open. Hinges are riveted on. No solder used.*
WE CAN MAKE ANY SIZE DESIRED
Also manufacturers of anything in sheet metal
Lyon Metallic Mfg. Co.
18-20 So. Ann St., Chicago, Ill.

Name Plates
for machinery
We make name plates for some of the largest makers of machinery in the U. S. and we would be pleased to send you sample and quote price.
No Plate Too Large or Too Small
Murdock Parlor Grate Co.
159 Boylston St., Boston, Mass. U. S. A.

$5 VOLT AMMETER FOR STUDENTS' USE.
(Jewell Bearing and Aluminum Case.) Adapted to primary and storage battery work. List of schools using it mailed on application. The method of its use described in a circular just issued.
L. E. KNOTT APPARATUS CO.,
16 Ashburton Place, - - BOSTON, MASS.

No. 109
BIT STOCK DRILLS
FOR METAL OR WOOD

MAKERS OF
Drills, Chucks, Reamers, Cutters, Taps, Dies, and Machinists' Tools
MORSE TWIST DRILL AND MACHINE COMPANY
NEW BEDFORD MASS. U.S.A.
Our Bit Stock Drills will fit any brace in the market, and will drill steel, iron, or other metals, as well as wood. They are not injured by contact with screws or nails, and will bore straight any kind of wood without splitting it.

Chicago Edison Company
REPAIR SHOPS
76 MARKET STREET, CHICAGO. TELEPHONE, MAIN 1260
FIRST-CLASS EQUIPMENT THROUGHOUT
Open Day and Night
DYNAMOS, ARMATURES, MOTORS, ARC LAMPS, INSTRUMENTS
Machine and carpenter work of all kinds. Correspondence Solicited

IF YOUR COPY IS RIGHT AND YOUR CUTS ARE GOOD
and your market is within the electrical and mechanical industries of the United States and foreign countries, you will get value from your advertising if in the NATIONAL ELECTRIC LIGHT CONVENTION REPORT NUMBERS, May 30 and June 6, 1903. Send copy instructions to either office—13 Park Row, New York, or 40 Dearborn Street, Chicago; 42 Old Broad Street, London, E. C.

THE RANGE OF THIS COMBINATION OF

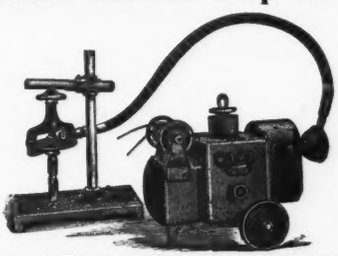
Flexible Shaft and Multi-Speed Motor

IS LIMITED ONLY BY THE LENGTH OF CONDUCTING WIRE ON THE REEL

For All-Around Portable Work it has no equal

DRILLING, TAPPING, REAMING, EMERY GRINDING

A Portable Machine Shop in Itself



The only practical Electric Motor with an infinite variety of speeds within extreme limits

SELF CONTAINED - - NO OUTSIDE STARTER OR RHEOSTAT

Shall We Mail You Catalogue?

Stow Manufacturing Co.

BINGHAMTON, N. Y.

General European Agents; SELIG, SONNENTHAL & CO., 85 Queen Victoria Street, LONDON, ENGLAND

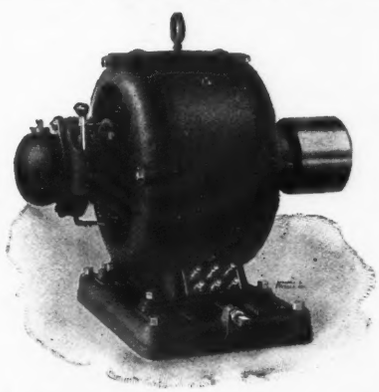
See Stationary Motors in Next Issue

Browning Motors and Dynamos

HIGH GRADE AND MODERN IN EVERY WAY

Motors, ... 1-8 to 15 H. P.
Dynamos, ... 1-2 to 12 1-2 K. W.

WRITE FOR BULLETIN



The Browning Manufacturing Co.

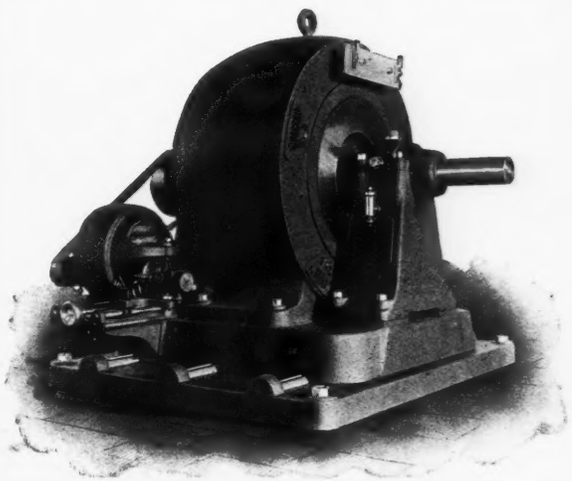
MILWAUKEE, U. S. A.

Eastern Representatives
D'OLIER ENGINEERING CO.
New York, Philadelphia, Baltimore

Southwestern Representatives
WESTERN ELECTRICAL SUPPLY CO.
St. Louis

Chicago Office: 1600 Tribune Building. R. LESTER THAYER, Manager
Cleveland Office, 560 Ross Building. E. C. MEYER
Foreign Department: GOUDEY-McLEAN CO., 88 Maiden Lane, New York

THE WARREN ALTERNATOR



Nothing is so essential in electrical machinery as reliability and nothing contributes so much to reliability as simplicity

The Warren Alternator is a machine of the maximum simplicity.

It is simplicity itself having no slip rings or commutator and no revolving wire.

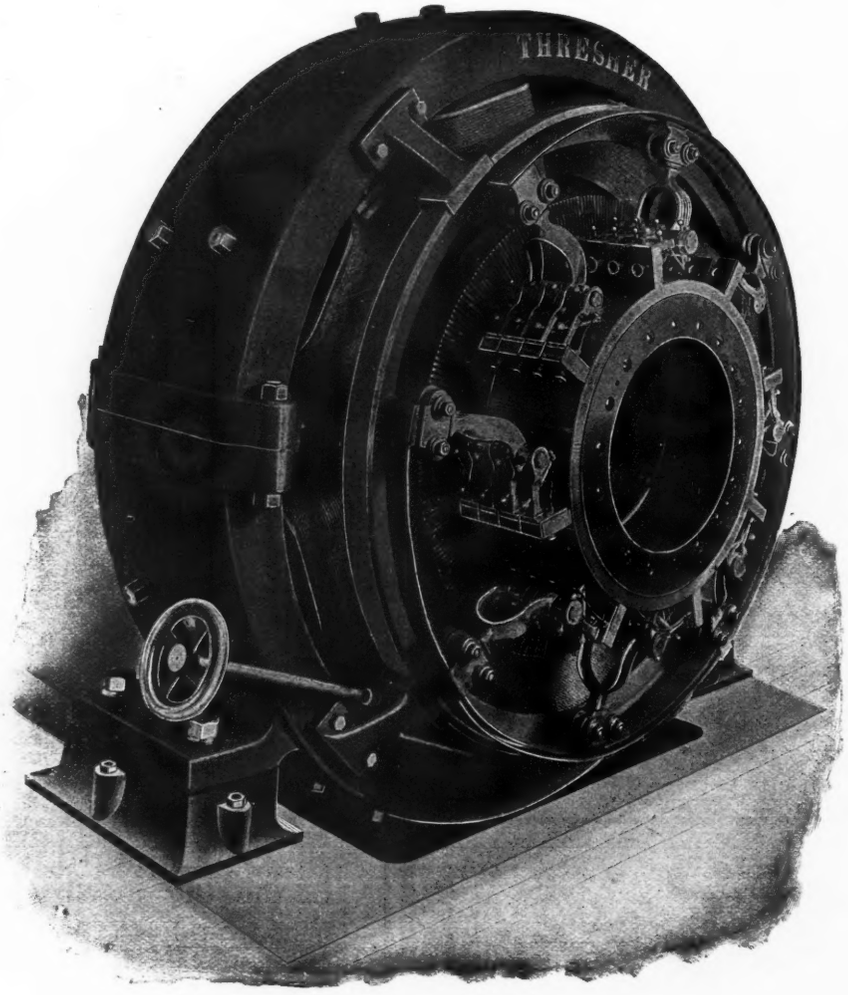
WARREN ELECTRIC MF'G. CO.

SANDUSKY, OHIO, U. S. A.

RUMSEY ELECTRICAL M'F'R'S CO., 1211 Filbert St., Philadelphia, Pa.
H. B. COHO & COMPANY, 114 Liberty St., New York
WESTERN ELECTRICAL SUPPLY CO., St. Louis, Mo.
C. W. HOBSON, Waco, Texas
KILBOURNE & CLARK CO., 815-817 Second Ave., Seattle, Wash., Pacific Coast Agents.
A. M. SEARLES, 1300 Fisher Building, Chicago, Ill.

THRESHER

Engine Type Generators possess all the essential features of a perfect running machine



THRESHER MULTIPOLAR GENERATOR

Complete Equipments for Electric Railways, Lighting and Power Transmission

Manufactured by

THE THRESHER ELECTRIC CO.

MAIN OFFICE AND WORKS
Dayton, Ohio, U. S. A.

NEW YORK OFFICE
120 Liberty Street

Crocker-Wheeler Company

MANUFACTURERS AND ELECTRICAL ENGINEERS

GENERATORS.

Characteristic features,

ELECTRICAL

Generous size of conductors

Strong Insulation

Divided fields for heat dissipation

Ample wearing depth for commutator bars

Separate brush shifting device for equalizing the magnetic circuits

MECHANICAL

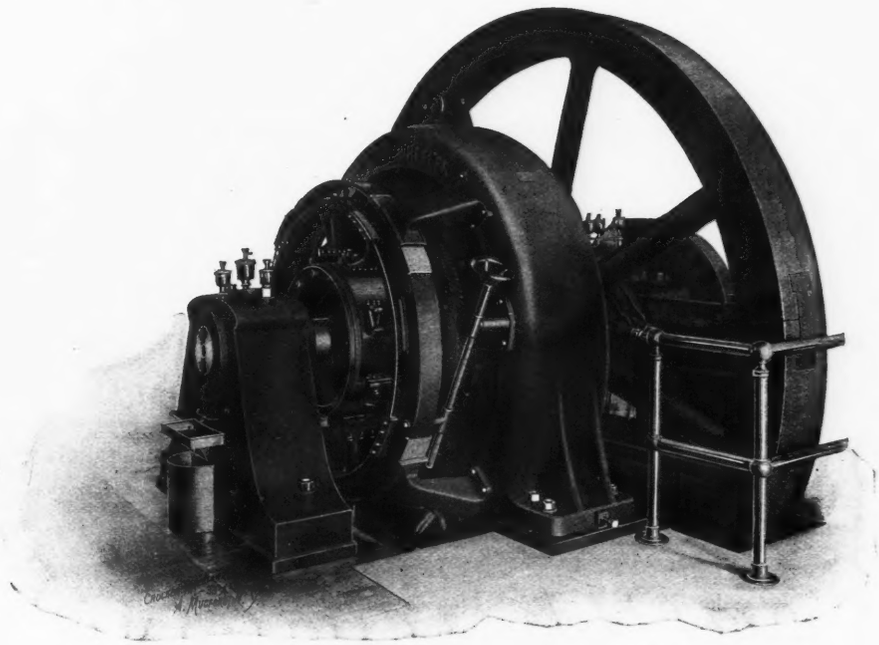
Rigid, well finished field frame

Open armature construction for air currents

Firm support for brush rigging

Secure method of holding armature segments in place

Simple, durable brush holders



OFFICE and WORKS, - - - AMPERE, N. J.

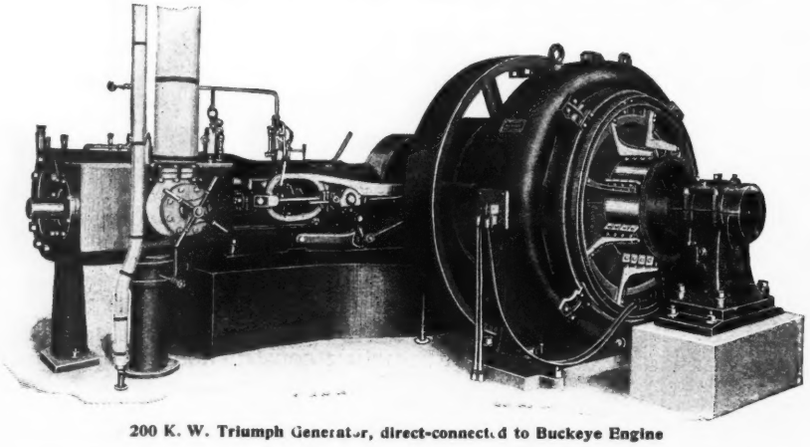
Branch Offices

Boston New York Philadelphia Washington Pittsburg St. Louis Chicago Denver San Francisco

TRIUMPH GENERATORS AND MOTORS

ARE THE

Standard of Excellence



200 K. W. Triumph Generator, direct-connected to Buckeye Engine

Our machines are constructed to give their maximum output without undue strain on any part. The design is simple and embodies all the latest improvements: all parts are readily accessible and easily adjusted.

We employ the highest engineering talent, and use only the best workmanship and materials, which is a substantial guarantee that our machines are both efficient and durable.

It will pay you to investigate.

ASK FOR BULLETIN "E R"

TRIUMPH ELECTRIC COMPANY

Main Office and Works
CINCINNATI, OHIO, U. S. A.

NEW YORK: 39 Cortlandt Street Branches in all large cities LONDON: 97 Victoria Street

NATIONAL ELECTRIC LIGHT CONVENTION

CHICAGO, MAY 26-28, 1903

To secure the greatest degree of COMFORT IN TRAVEL arrange to take one of the fast trains

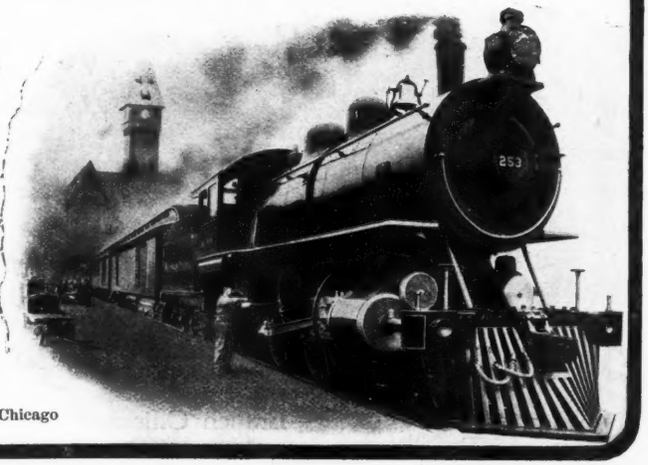
OF THE

MICHIGAN CENTRAL

THE NIAGARA FALLS ROUTE

Through Sleeping Cars from

BOSTON
NEW YORK
and BUFFALO
to
CHICAGO



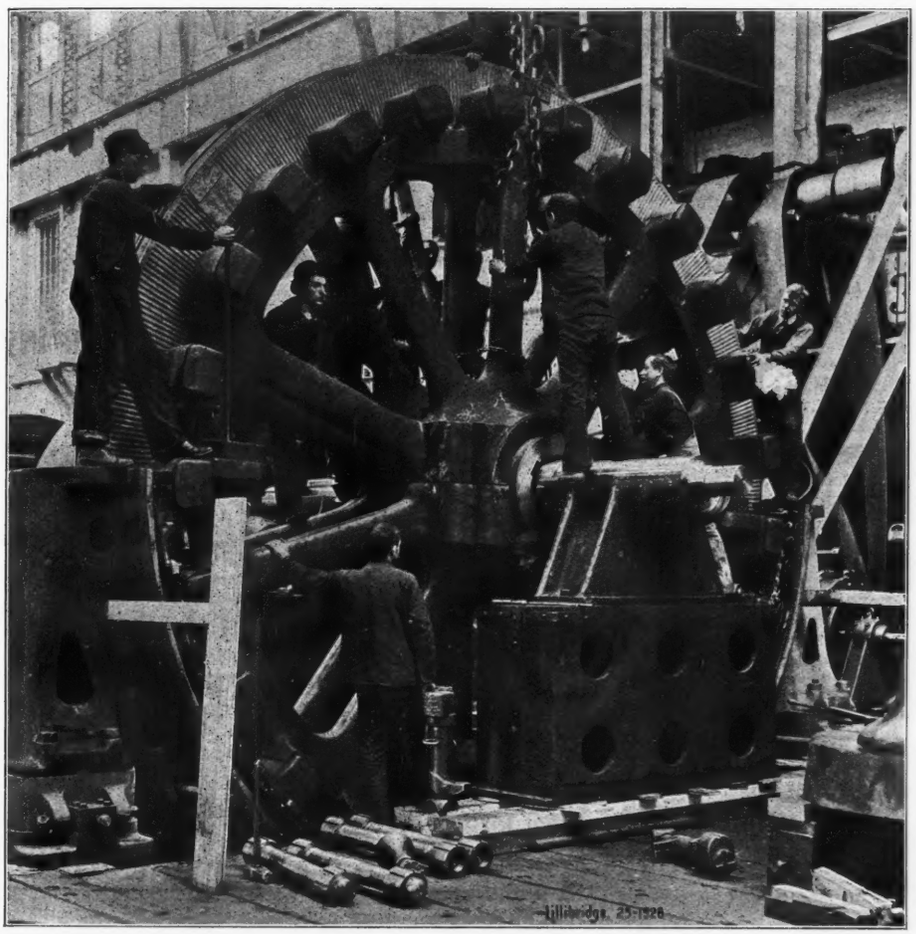
For rates and information call on local agents or write

W. H. UNDERWOOD,
G. E. P. Ag't, Buffalo

O. W. RUGGLES,
G. P. & T. Ag't, Chicago

The SKC System

Inductor Generator



S. K. C. Inductor Alternator in course of construction, showing the moving element, the inductor, and the Stationary Field Coil. This Generator is rated at 1,800 Kilowatts and will run direct-connected to an engine operating at 75 revolutions per minute. Two machines of this type were recently furnished the Pacific Electric Railway Company of Los Angeles, Cal.

is entirely free from complication of any kind.

The field coil is stationary, the armature is stationary, and there are neither brushes, collectors nor moving wires of any kind.

Wear and tear are only such as can result from the simplest known mechanical movement—a shaft revolving in bearings.

There is no "theory" about paralleling S.K.C. machines—they simply do it.

Stanley Electric Mfg. Company

Pittsfield, Mass.

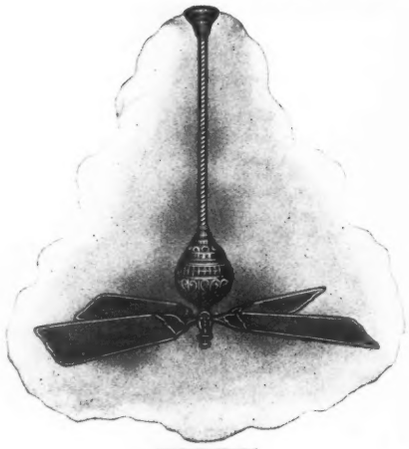
BRANCH OFFICES:

NEW YORK, 29 Broadway.
CHICAGO, Monadnock Block.
BOSTON, Equitable Building.
PHILADELPHIA, 26 S. 15th St.
ST. PAUL, MINN., 131 East Fifth St.
BUFFALO, N. Y., 202 Main St.
DETROIT, MICH., Mich. Electric Co.
CLEVELAND, O., 129-131 Euclid Ave.
SAN FRANCISCO, 31-33 New Montgomery St.
LOS ANGELES, CAL., Douglas Bldg.
GREENSBORO, N. C.
DENVER, COLO., Hendrie & Bolthoff Mfg. & Supply Co.
SEATTLE, WASH., Pioneer Bldg.
BUTTE, MONT., Western Mining Supply Co.
ATLANTA, GA., Empire Building.

In Canada S. K. C. Apparatus is manufactured by the CANADIAN GENERAL ELECTRIC CO., TORONTO.

Lillibridge, N. Y., 25-1008

Tuerk
Alternating Current Ceiling Fans
1903 MODEL



4-Blade Model

The high standard of excellence possessed by the "Tuerk" Alternating Current Ceiling Fans during the eight years that they have been on the market, will be fully maintained by the 1903 models. They are made with 2 and 4 blades, with and without electrolier attachments.

Spread of blades 60 inches, width 8 inches. Speed 175 R. P. M.: Current consumed, 100 Watts; Cycles, 40 to 140; Voltage, 52 to 230.

Write for catalogue and prices.

HUNTER FAN & MOTOR CO.
Fulton, N. Y., U. S. A.

General and Export Agents: E. B. Latham & Co., 39 Vesey Street New York, U. S. A.

Western Agents: Western Electric Co., Chicago, Ill. Western Electric Co, 810 Spruce Street, St. Louis, Mo.

DIEHL EXHAUST FANS

Our Type "C" Motor was designed for ventilating uses. Entirely enclosed, excluding smoke, fumes, dust, etc. Easily accessible. High efficiency. Low heat limit. Horizontal or vertical. **ALL SIZES.**

DIEHL MANUFACTURING COMPANY
ELIZABETHPORT, N. J.

BRANCHES: NEW YORK, BOSTON, PHILADELPHIA

"THE AXLE LIGHT" SYSTEM OF ELECTRIC LIGHTS AND FANS
FOR ALL KINDS OF PASSENGER CARS

As the "up-to-date method" of car lighting is being used by leading railway lines and is, of course, always preferred by the traveling public.

Consolidated Railway Electric Lighting & Equipment Co.
WESTERN OFFICES: 83 WEST JACKSON BOULEVARD, CHICAGO. GENERAL OFFICES: 100 BROADWAY, NEW YORK.

Otis Electric Elevators
71 BROADWAY NEW YORK

McINTIRE'S PATENT
Connectors and Terminals.
Special Connectors for HARD-DRAWN COPPER WIRE, all sizes. FUSED WIRE, FUSED LINKS and STRIPS.
THE C. McINTIRE CO.,
13 & 15 Franklin St., Newark, N. J.

ENCLOSED ARC LAMPS
For All Circuits
THE OSBORN-MORGAN CO.
Cleveland, Ohio

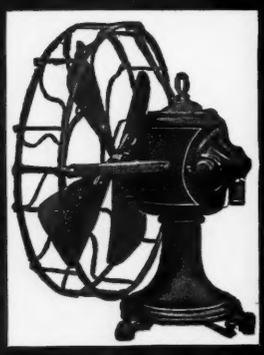
M. J. BLAKE MICHAEL BLAKE
M. J. & M. BLAKE
IRON AND STEEL SCRAP
79 TENTH AVENUE
COR. 15TH STREET
Telephone Connection 897 18th St. NEW YORK

G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I. G.I.

G. I. Co.'s
MINIMUM COST OF CURRENT
NO REPAIRS TROUBLE NOISE
MAXIMUM VOLUME OF AIR

MANUFACTURED BY
General Incandescent Arc Light Co.
NEW YORK, N. Y.

PARAGON



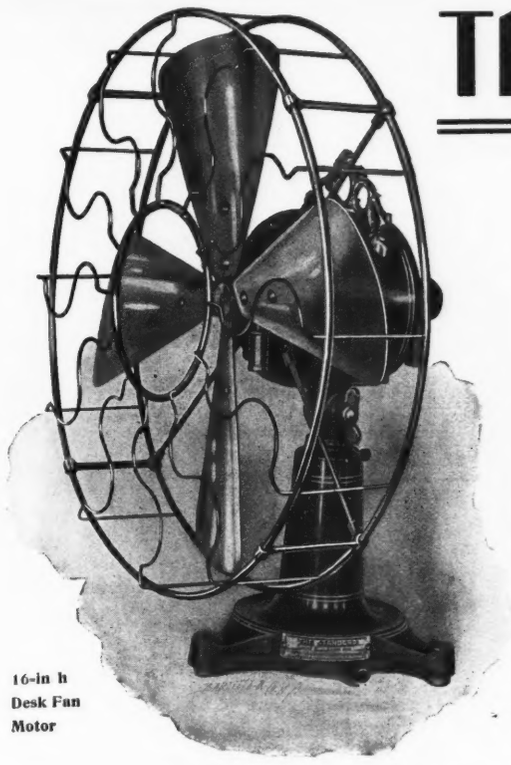
TRUNNION DESK FANS

BRACKET

FANS
A CHEAP IS THE DEAREST **FAN**

PARAGON FAN AND MOTOR CO.
572-578 First Ave., New York, N. Y.

OFFICES IN EVERY LARGE CITY OF THE U. S.



16-in h Desk Fan Motor

The Standard Fans

THE STORY IN BRIEF

STYLE "A"—Four 25-inch blades, 20 degrees angle, 200 r. p. m., 95 watts at full speed. Finished in three styles.

STYLE "B"—Four 25-inch blades, 20 degrees angle, 200 r. p. m., 110 watts at full speed. Finished in three styles.

500 V. SPECIAL—Four 25-inch blades, 20 degrees angle, 200 r. p. m., 0.2 amp., finished in black enamel with gold lines, and lacquered brass trimmings.

12-INCH DESK OR BRACKET—1,800 r. p. m., 40 watts at full speed.

16-INCH DESK OR BRACKET—1,500 r. p. m., 70 watts at full speed.

Desk and Bracket Fans are adjustable in all directions, and finished in black enamel with gold lines and lacquered brass trimmings.

Circulars Upon Request

THE ROBBINS & MYERS COMPANY

Main Offices and Works: SPRINGFIELD, OHIO **New York Office: 170 BROADWAY**

Look Over, Please

the recent EXPORT and DOMESTIC NUMBERS (published the second issue of each month) of the Electrical Review and note how comprehensive the advertising pages are of the Standard Electrical Equipments and Products. The next EXPORT and DOMESTIC NUMBER appears June 13. Send copy to either office

40 Dearborn Street CHICAGO | 13 Park Row NEW YORK | 42 Old Broad Street, E. C. LONDON

H. B. COHO & COMPANY, INC.

We carry in stock in New York City a full line of "ECLIPSE" Fan Motors, and power motors for general and special use from ⅛ to 10 H.-P.

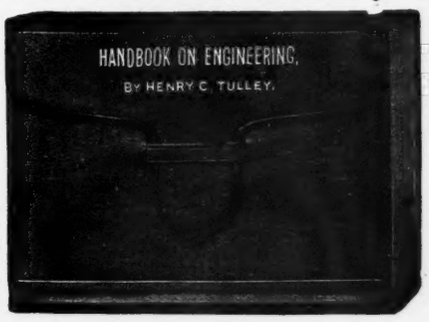
WE SELL GENERATORS AND MOTORS OF ALL SIZES

CATALOGS

114-118 Liberty Street, - - - - NEW YORK

THE BEST AID TO SUCCESS

An Encyclopedia of information, and in itself the most complete Library on Engineering practice ever published for the use of STEAM USERS, ENGINEERS ELECTRICIANS FIREMEN AND MACHINISTS



This Work Contains

Over 900 pages and 400 fine illustrations. Every branch of Engineering treated in a scientific and comprehensive manner. In it will be found a solution of the many knotty problems met in daily practice.

It is thoroughly reliable and practical; it is not only a guide, but a teacher.

As a reference and text-book it is the fullest, latest, and best authority on the subjects treated. It extends to details not found elsewhere.

Indorsed by the foremost practical men in the world.

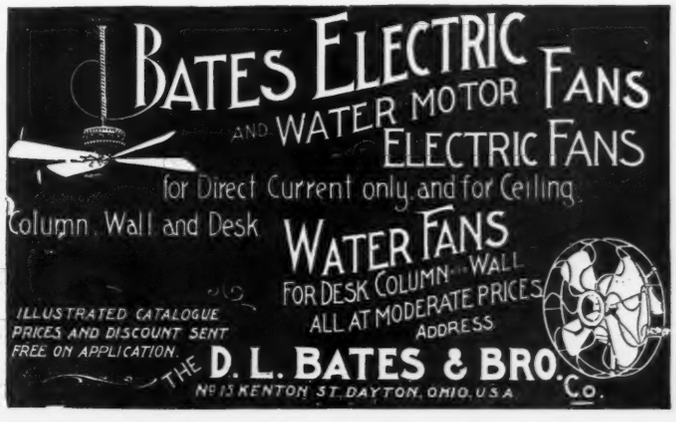
Handsomely bound in leather and gilt. Pocket-book form.

The 3d edition now ready

Sent anywhere on receipt of price, $3.50, money back if not satisfactory.

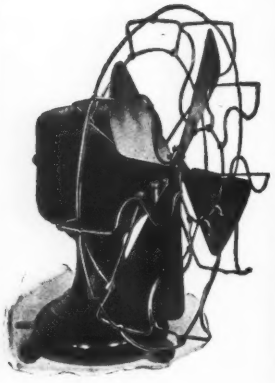
Send for 43-page illustrated circular

HENRY C. TULLEY & CO., 910 Wainwright Building, ST. LOUIS, MO., U. S. A.

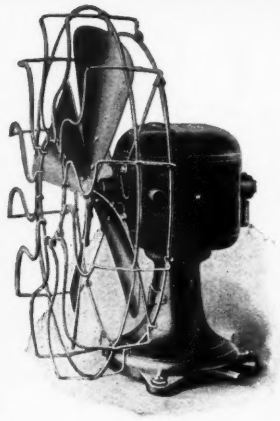

BATES ELECTRIC
AND WATER MOTOR FANS
ELECTRIC FANS
for Direct Current only, and for Ceiling
Column, Wall and Desk
WATER FANS
FOR DESK COLUMN AND WALL
ALL AT MODERATE PRICES
ADDRESS
ILLUSTRATED CATALOGUE PRICES AND DISCOUNT SENT FREE ON APPLICATION.
THE D. L. BATES & BRO. CO.
No. 13 KENTON ST. DAYTON, OHIO, U.S.A.

EVERY : : : : :
ELECTRIC LIGHT
GENERAL MANAGER

Reads the *Electrical Review* weekly. An inquiry will substantiate this. Do you wish him to see your advertisement?



DIEHL FAN MOTORS



NEW 16-INCH DESK

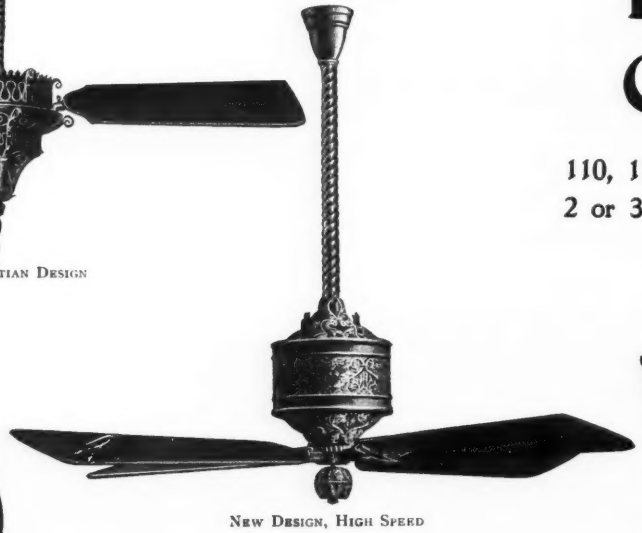
Ceiling Fans

For all conditions of service
Noiseless
Perfect oiling arrangement
Low current consumption
Large circulation of air
Artistic Designs

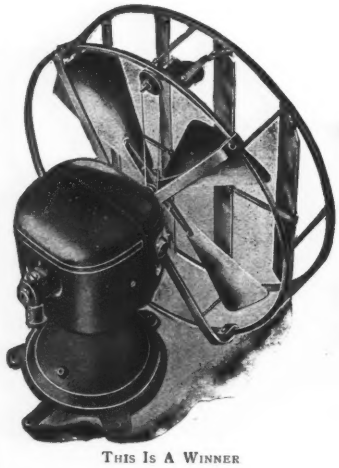
SPECIAL VENETIAN DESIGN

Direct Current

110, 170, 220, 250 and 500 Volts
2 or 3 Speeds - 2 or 4 Blades
12 Styles



NEW DESIGN, HIGH SPEED

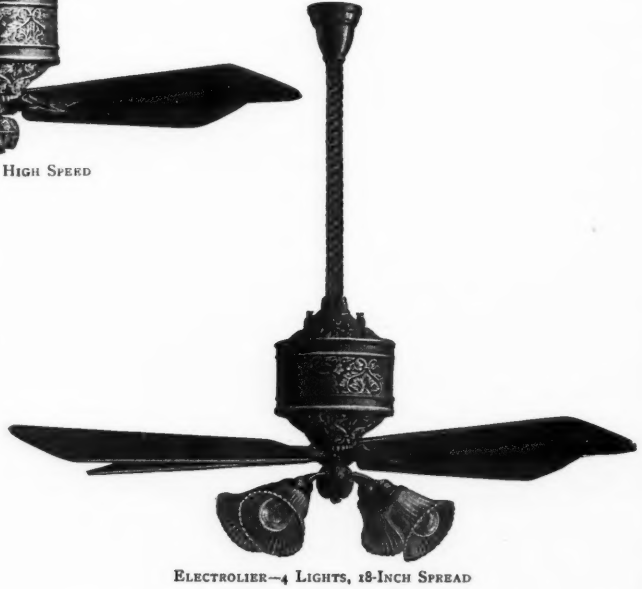


THIS IS A WINNER

Our 15 Years Experience

In the development of the Art insures perfection in all details

Our New Desk and Bracket Fans are attractive in appearance and the best sellers because they are made right and never give trouble. You should send for sample *Coleman Guard and Deflector.* Everyone likes the idea



ELECTROLIER—4 LIGHTS, 18-INCH SPREAD

Diehl Manufacturing Company

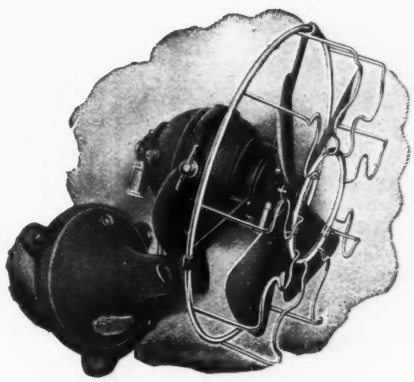
MAIN OFFICE AND WORKS
Elizabethport, N. J.

BRANCHES
New York, Boston, Philadelphia

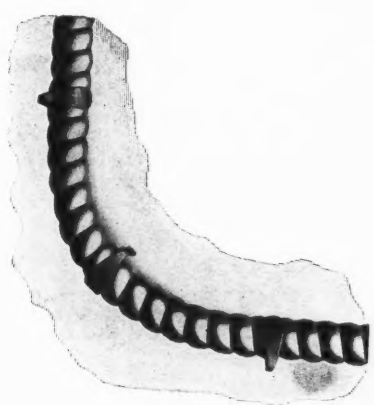
LUNDELL FANS

The practical value and utility of the Lundell Fans are due to their superior design and construction. They have long been proven and acknowledged to be the best electric fans on the market. They are the most efficient, most durable and the most graceful in appearance. They have a strong torque, run easily and quietly and require the least attention. They are made in various types and sizes to meet all requirements of location. If you want an electric fan you want a Lundell.

Write for catalogue No. 3066.



Interior Conduit



The conduits and appliances manufactured by the Sprague Electric Company under the Greenfield patents, are designed for use in every climate and under all conditions. For each type of conduit there is a full line of junction boxes, fittings, tools, etc.

The Flexible Metallic Conduit and Flexible Steel Armored Conductors represent the highest development in the art of electric wiring and reduce installation to an absolute simplicity.

Write for bulletins No. 4116 and No. 4126.

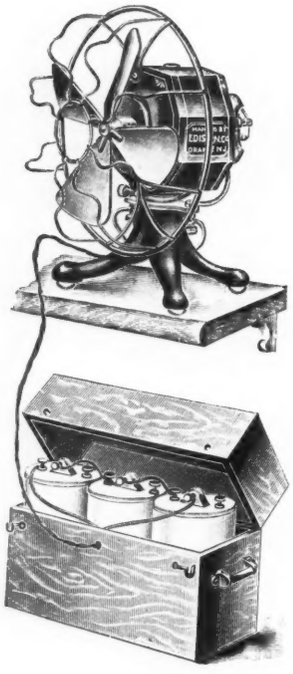
SPRAGUE

ELECTRIC COMPANY

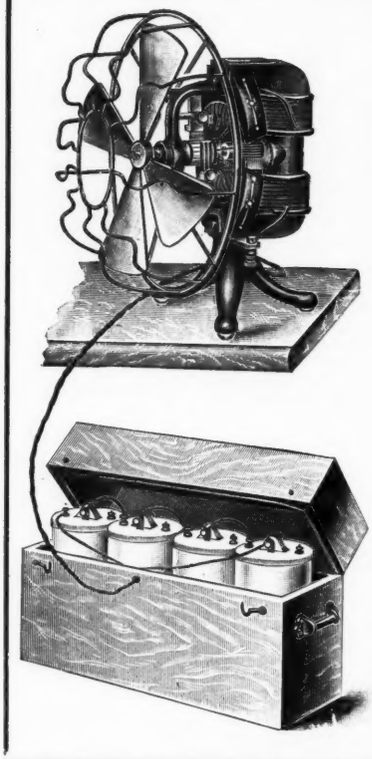
General Offices: 527-531 West 34th Street, New York

BRANCH OFFICES

CHICAGO	BOSTON	ST. LOUIS	BALTIMORE
Fisher Building	Weld Building	Security Building	Maryland Trust Building



EDISON BATTERY FAN OUTFITS



Most efficient on the market. Invaluable for the sick-room. Makes the bed-room comfortable in summer. Fans are noiseless.

WRITE FOR CATALOGUE 17A

EDISON MANUFACTURING COMPANY

FACTORY, ORANGE, N. J.

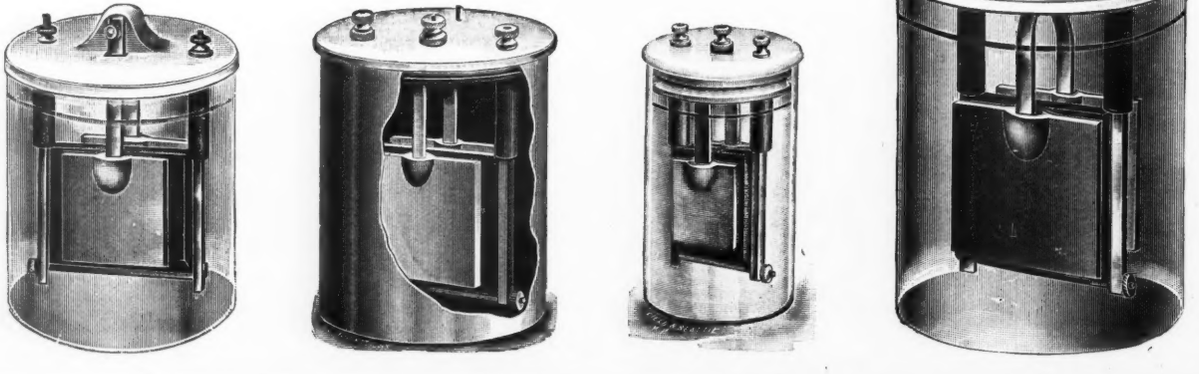
New York Office = = = = = = = 83 Chambers Street
Chicago Office = = = = = = = = 304 Wabash Avenue

EDISON PRIMARY BATTERIES

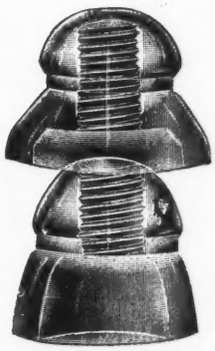
MADE IN NINE DIFFERENT TYPES

Best for Gas Engines, Railway Signals, Fan Motors, Phonographs, and all kinds of work requiring Primary Batteries

SEND FOR CATALOGUE 17B



"HEMINGRAY"
STANDARD
Screw Glass Insulators



Two-Piece
Transposition.

All with the
"Patent Drip
Petticoats."

The Hemingray Glass Co.

Office, Covington, Ky. Factory, Muncie, Ind.

ESTABLISHED 1848

This Trade Mark is on the Best Switch Made

USE NO OTHER IF
TRADE
MARK
YOU DESIRE THE BEST
Necessary Wherever Incandescent Electric Lighting is Used
Send For Circular Matter and Prices on Our Switches

THE HART MFG. CO., Hartford, Conn., U. S. A.

"It expounds the whole philosophy of push and publicity."—LONDON TIMES.

Successful Advertising

HOW TO ACCOMPLISH IT

By J. ANGUS MacDONALD

Clearly, cleverly, and interestingly written. 400 pages full of practical and necessary information. Indispensable to all advertisers, business people, clerks, students, managers, buyers—every one wishing to progress through

Right Advertising

REGARDING ITS APPEARANCE, the Advertising World, Columbus, O., says: "It is a beautiful piece of work, printed on deckle edge, antique, cream-tinted paper, in brown ink. 400 pages, bound in green buckram, with the title stamped in gold leaf."

REGARDING ITS STYLE, Printers' Ink, New York, says: "Where the usual volume on retail advertising quotes stale advertising phrases and gives hackneyed specimens, Mr. MacDonald searches out the inner advertising principles of each business and sets it forth clearly and briefly. His matter all through the book is distinguished for compactness and clarity, and is written in a sprightly, forceful way."

REGARDING ITS PRICE, the Ad Smith, Parkersburg, W. Va., says: "To have this book in one's office is equivalent to the services of an expert advertising writer. The price of 'Successful Advertising' is $2.00, and we are frank to say that we have gotten at least $100 worth of information, and the book is not one-fourth read."

B. S. Cooban, Chicago, says: "The first ten pages are worth the money."

400 Pages in Cloth and Gold. Completely Indexed. Postpaid for $2.00

ELECTRICAL REVIEW, 13 Park Row, N. Y.

MICHIGAN COLLEGE OF MINES
F. W. McNAIR, President.

Regular summer term opens June 8. For Year Book giving list of graduates and their occupations, apply to President or Secretary, Houghton, Michigan.

ROSE POLYTECHNIC INSTITUTE

Terre Haute, Ind. A College of Engineering, Mechanical, Electrical, Civil Engineering; Chemical course, Architecture. Extensive shops. Modernly equipped laboratories in every department. Expenses low. 21st year. For catalogue address C. L. MEES, President.

McGILL UNIVERSITY MONTREAL CANADA

Courses in Architecture, Civil Engineering, Mechanical Engineering, Electrical Engineering, Mining Engineering, Practical Chemistry.

For descriptive pamphlet or information, address

J. A. NICHOLSON, Registrar
HENRY T. BOVEY, Dean

University of Wisconsin MADISON WIS.
College of Mechanics and Engineering

Courses in Civil, Sanitary, Mechanical, Electrical and Electro-Chemical Engineering. All professional instruction given by men of large practical experience in their respective departments. Completely equipped shops and laboratories. Graduate students received in all courses. Gymnasium, boating facilities and athletic opportunities unexcelled. Fees moderate. "Madison has the most magnificent site of any inland town of America." It is as healthful as it is beautiful. For catalogue or information, address

J. B. JOHNSON, DEAN, Madison, Wis.

EUREKA

Coloring and Frosting Compounds are PERFECTION

For Incandescent Electric Light Globes

Put up in any size package from 4 ounces to 5 gallons. Write for prices.

EUREKA ELECTRIC COLOR CO.
21 & 23 Ann Street New York

The Franklin Model Shop

Experimental work for inventors; anything in metal from a single piece to a complete working model. Apparatus for colleges. Exhibition models. Introduction samples of patented articles. Special tools for making metal novelties. Inventions perfected. Drawings and designs worked out from inventors' ideas. Send for circular No. 2.

PARSELL & WEED
129-131 West 31st St., New York.

EXPOSITION FLYER

VIA

"BIG FOUR"

FROM

CINCINNATI

TO

ST. LOUIS

WRITE FOR RATES AND FOLDERS

WARREN J. LYNCH, Gen'l Pass. & Tkt. Agt.
W. P. DEPPE, Asst. Gen'l P. & T. A.
CINCINNATI, OHIO

ELECTRIC DIALS

The most convenient and reliable method of furnishing uniform time in factories, schools, mills and other large buildings. Readily installed and easily maintained. Also Frying-Pan, Program, Sixty-Day and Calendar Clocks.

Send for Catalogue No. 203.

The Prentiss Clock Improvement Co.
Dept. 20, 49 Dey St., NEW YORK CITY

IMPROVED ELECTRICAL THEATRICAL APPLIANCES

Attaching Plugs
Open Box Lights
Lens Boxes
Bunch Lights, etc.

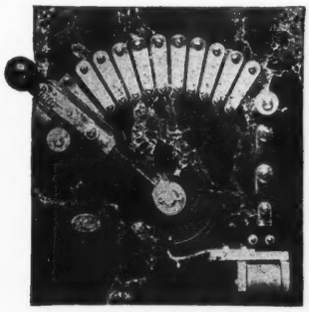
JOSEPH P. MENCHEN
1237 Broadway - New York

W. R. OSTRANDER & CO.
22 DEY STREET, NEW YORK,
MANUFACTURERS OF
Speaking Tubes, Whistles, Annunciators.
Electric and Mechanical Bells.

FACTORY: DEKALB AVE. BROOKLYN.

Send for Illustrated Catalogue.

C & H



MOTOR-SPEED REGULATORS
WITH
AUTOMATIC RELEASE

ANY H. P. ANY VOLTAGE

The Cutler-Hammer Mfg. Co.
Milwaukee, Wis.

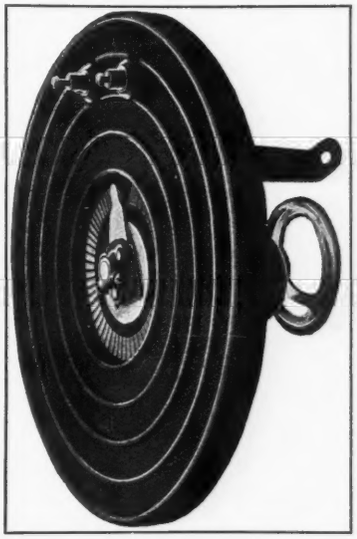
Chicago
1232 Monadnock Bldg.

New York
136 Liberty St.

Pittsburg
319 Frick Bldg.

The Wirt Rheostat

Now here's a good thing on the face of it



But some of the good points are on the inside

Write us and we will give you the inside facts

The Wirt Electric Company
182 Broadway, New York

FACTORY PHILADELPHIA
SALES NEW YORK
BRANCH CHICAGO

BROOKFIELD

SCREW-GLASS

FOR HIGH VOLTAGE

INSULATORS

We develop and manufacture special designs of all types of insulators to meet all requirements for high voltage transmission. Correspondence Invited

Brookfield Glass Co., New York

Why don't YOU Buy THIS Socket?

The Yost

It has numerous advantages over the next best.

Find Out About It.

It don't cost you anything.

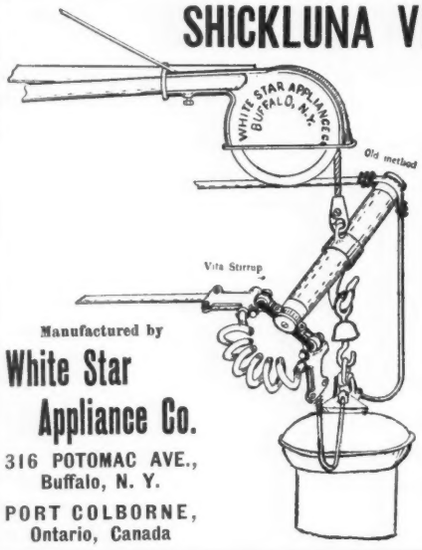
THE YOST ELECTRIC MFG. CO.,
TOLEDO, OHIO, U. S. A.

AUDITORIUM HOTEL

SPECIAL NOTICE

A specially arranged dark room has been set aside where day and night demonstrations will be given of our scientific prism glass globes and other optical illuminating appliances. HOLOPHANE GLASS CO., New York.

SHICKLUNA VITA STIRRUP



The ideal receptacle for transmission wires delivering energy to lamps, or to swinging electrical devices.

This cut shows it in use on an insulator and arm, and also shows the old method.

Manufactured by
White Star Appliance Co.
316 POTOMAC AVE., Buffalo, N. Y.
PORT COLBORNE, Ontario, Canada

THE HUBBELL UNIVERSAL ATTACHMENT PLUG

BASE SCREWS IN — CAP SNAPS ON

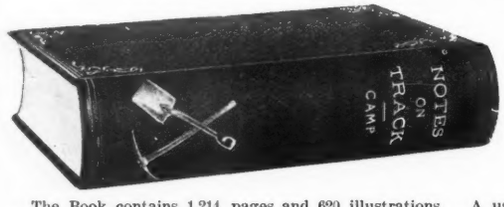
Made for new and old code cord or cable.
No twisting of the wire.
Best plug for the fan motor.
For sale by all the jobbers.

Manufactured by
HARVEY HUBBELL
MAIN OFFICE & FACTORY, BRIDGEPORT, CONN.
93 Nassau St., New York Chicago

NOTES ON TRACK

By W. M. CAMP, M. Am. Soc. C. E.

AN EXHAUSTIVE TREATMENT OF TRACK CONSTRUCTION AND MAINTENANCE FROM A PRACTICAL STANDPOINT



Up to Date
Just
Issued
1903

The Book contains 1,214 pages and 620 illustrations. A useful book to all concerned with

INTERURBAN OR SUBURBAN ELECTRIC RAILWAYS

Bound in cloth, 6½ x 10 inches. **Price $3.00 per copy, postage paid.** Send for illustrated circular giving full table of contents.

W. M. CAMP, 2d Floor, 7418 Parnell Ave., Chicago.

To Advertisers

Advertisers, who desire, may get the benefit of our "copy" department, which includes the following: advertising writing, staff artist, engraving in half-tone or line work and special composition work. The charge for this work to advertisers is exceedingly moderate. The department has been organized for the benefit of advertisers. Address

Electrical Review
13 Park Row, New York
40 Dearborn Street, CHICAGO
42 Old Broad Street, LONDON, E. C.

GETTYSBURG AND WASHINGTON.

Personally-Conducted Tour via Pennsylvania Railroad.

The battlefield of Gettysburg, and the National Capital in all the glory of its Spring freshness, are attractions so alluring that few would feel like refusing to visit them. It is to place these two attractions within easy reach of every one that the Pennsylvania Railroad Company announces a tour over the interesting battlefield, through the picturesque valleys of Maryland, and an entertaining stay at Washington.

The tour will leave New York 8.00 A. M., and Philadelphia 12.20 P. M., Saturday, May 23, in charge of one of the Company's tourist agents, and will cover a period of six days. An experienced chaperon, whose especial charge will be unescorted ladies, will accompany the party throughout. Round-trip tickets, covering transportation, carriage drives, and hotel accommodations, will be sold at the *extremely low rate* of $22 from New York, $21 from Trenton, $19 from Philadelphia, and proportionate rates from other points.

For itineraries and full information apply to ticket agents; Tourist Agent, 263 Fifth Avenue, New York; 4 Court Street, Brooklyn; 789 Broad Street, Newark, N. J.; or address Geo. W. Boyd, Assistant General Passenger Agent, Broad Street Station, Philadelphia.

WIRE

The Magnet Wire Co.
141 BROADWAY, NEW YORK

ALL SIZES MAGNET, WEATHERPROOF, ANNUNCIATOR, OFFICE, RUBBER-COVERED, TROLLEY and BARE WIRES. We carry at all times a large stock of the above sizes ready for immediate shipment

Otis Elevators

FOR USE IN RESIDENCES

THE Otis Automatic Electric Elevator is automatic in the fullest sense of the word. It requires no attendant and a child can operate it. On each floor is a single push button at the landing and in the car is a row of push buttons, one for each floor. The car responds to the pressing of a button by coming to the floor you are on and stopping itself there. Until it has stopped the door is locked and the only door unlocked is the one at which the car is at rest. Upon entering the car and closing the door behind you, pressing one of the buttons causes the car to proceed to the corresponding floor and stop there, releasing the door for your exit. Until you have passsed out and closed the door again the car will not respond to any interfering call. Power may be derived from any lighting circuit. The task of arranging houses already built, for an elevator is not formidable.

CORRESPONDENCE INVITED

Otis Elevator Company

NEW YORK OFFICE, 71 BROADWAY

BRANCH OFFICES THROUGHOUT THE COUNTRY

Lillibridge, N. Y.—28-900.

American Conduit Co.

MANUFACTURERS OF

Bituminized Fibre Conduit

(PATENTED)

For Underground Electrical Work...

This Conduit Is { ELECTROLYSIS PROOF, NON-ABRASIVE, MOISTURE PROOF, NON-CORROSIVE } Insulating Test 66,000 Volts

Strong, Light, Tough

Made in seven-foot lengths. 2 to 8 inches diameter. A perfect air-tight, water-tight joint. Self-aligning, making the ducts a continuous tube from manhole to manhole. Construction simple, rapid and inexpensive. Easiest and smoothest duct for drawing cables through. Bituminized Fibre Conduit not only possesses these EXCLUSIVE POINTS OF SUPERIORITY, but several million feet have stood the test of a number of years' use under various conditions by leading telephone, lighting and power companies without deterioration.

American Conduit Co.

OFFICES	Factories
720 Arcade Building, Philadelphia	PHILADELPHIA
822 Manhattan Building, Chicago	CHICAGO
336 Macy Street, Los Angeles	LOS ANGELES

Williams Spark Coils

Have been adopted by the leading manufacturers and supply houses

Evening Star Flash Lamps

and other

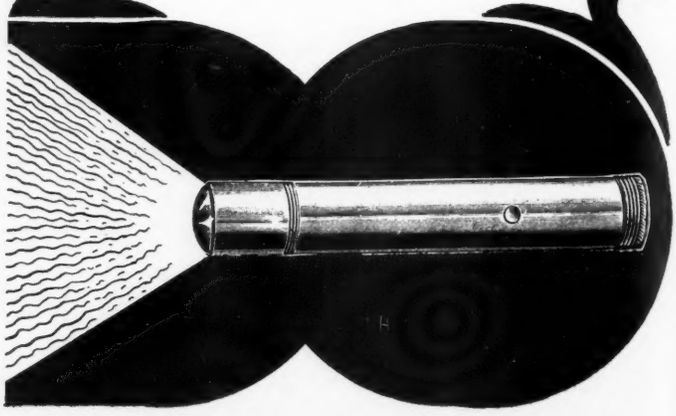
Electric Novelties

The Best and Cheapest on the Market

WRITE FOR PRICES AND TERMS

ELECTRIC CONTRACT CO.

154 Lake St., Chicago 202-204 Centre St., N. Y.



VITRIFIED CLAY CONDUITS

MULTIPLE CONDUITS SINGLE

Secure SAMPLES and PRICES from us BEFORE CLOSING your CONTRACTS.

We have LARGE FACTORIES in the EAST and WEST.

PROMPT DELIVERIES.

Write or telephone and we will call and see you. Telephone 5928 Broad

C. J. FIELD
29 BROADWAY
NEW YORK

COME AND SEE US

AT THE
CHICAGO CONVENTION

Our New Type Telephone is now ready

Button Type Transmitter
Solid Receiver
All Contact is Positive
Adapted for any System

AMERICAN PUSH BUTTON TELEPHONE CO.

136 LIBERTY STREET, NEW YORK

Automatic Telephones

Privacy
Promptness
Precision of
Service are the
Points of Excellence
In the Automatic Exchange
Which Especially Commend it
To the Telephone Public.
Profitable Operation
And Durability
Commend it to
All Exchange
Managers

Automatic Electric Company, CHICAGO U. S. A.

For the Twenty-sixth Convention of the

National Electric Light Association the ELECTRICAL REVIEW will publish two especially large and sumptuous numbers. These numbers will cover, strikingly, the advances of electric lighting and central station engineering of the past year. They will be conspicuous examples in valuable editorial features, finely illustrated and well printed. These issues will be dated

May Thirty and June Six

and will contain complete and accurate reports of the proceedings, papers, attendance, etc., etc., of this convention. These two numbers will be essential for the information of up-to-date engineers and electricians and the numbers will have an extraordinary circulation throughout the electrical and engineering industries of the United States and Foreign Countries.

Advertisers who desire space in these numbers should address

The Electrical Review
13 Park Row New York
Chicago, 40 Dearborn Street London, 42 Old Broad Street

BANNER LAMPS

DEMAND RESPECT

They are **RECOGNIZED** as **SUPERIOR** by hundreds of the most critical consumers.

COMPETITIVE TESTS = BANNER ORDERS

Now is the time to get in line for "Banner Betterness."

THE BANNER ELECTRIC CO.
YOUNGSTOWN, OHIO

ELECTRICAL REVIEW.

SOMETHING NEW!

IN LINE WITH THE TWENTIETH CENTURY ADVANCEMENTS OF THE WORLD'S INDUSTRIES

WHEN THE COVERS TO PRACTICAL ELECTRICITY ARE THROWN BACK

The Student, the Steam Engineer, the Practical Man, the Electrical Engineer and the College Professor see therein a new light, illuminating the way to an easy and effective method of studying the art of Electricity. The publishers have on file over four hundred letters, the writers ranging in rank from beginner to noted Electrical Engineers, commenting on the merits of this new work.

BOOK CONTAINS

287 Pages of Subject Matter.

162 Pages Dictionary and Tables.

427 Questions and Answers.

95 Illustrations.

20 Tables (all that's required).

Size 6 x 4¾ inches.

Flexible Binding.

Set in 8-Point Type, a good, readable size.

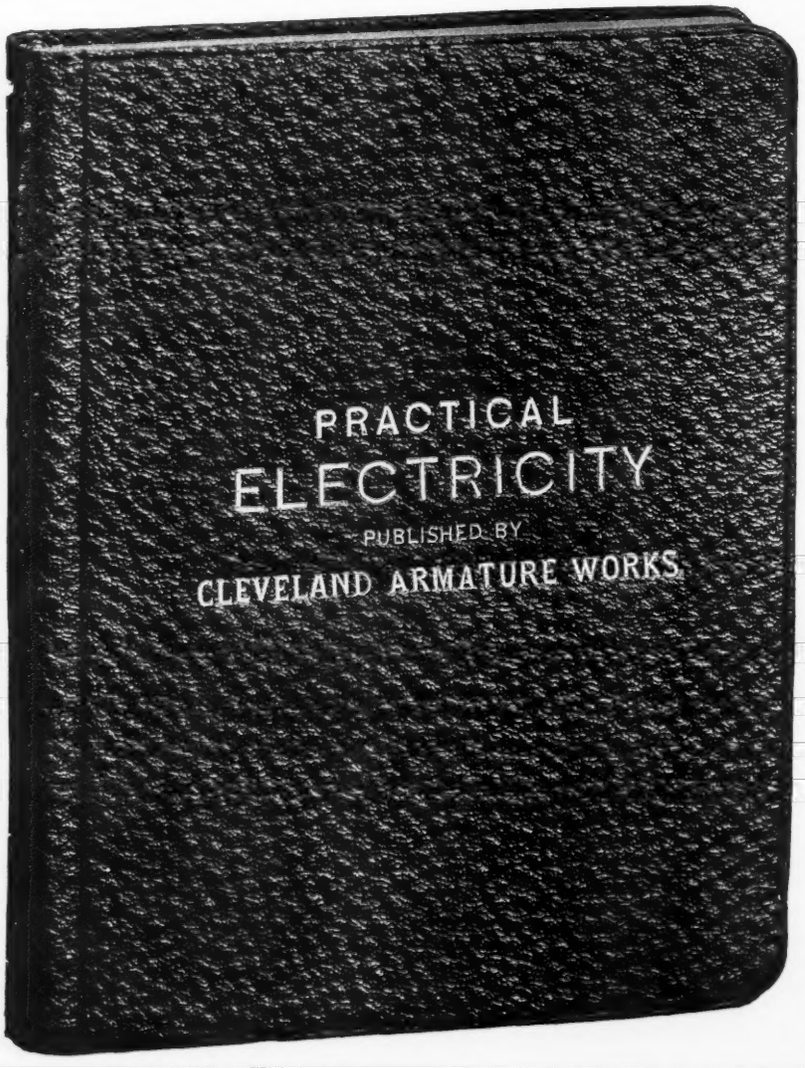


TABLE OF SUBJECTS

CHAPTER

I—Wiring.
II—Electric Batteries. Electric Plating.
III—Magnetism.
IV—The Magnetic Circuit.
V—Magnetic Traction.
VI—Magnetic Leakage.
VII—Energy in Electric Circuit.
VIII—Calculation of Size of Wire for Magnetizing Coils.
IX—Calculation of E. M. F.'S in Electric Machines.
X—Counter E. M. F.
XI—Hysteresis and Eddy Currents.
XII—Armature Reaction.
XIII—Sparking.
XIV—Winding of Dynamos and Motors.
XV—Proper Method of connecting Dynamos and Motors—Self-Excitation.
XVI—Diseases of Dynamos and Motors, their Symptoms and How to Cure Them.
XVII—Arc and Incandescent Lamps.
XVIII—Measuring Instruments.
XIX—Alternating Current.

A Dictionary of over 1,500 Electrical Words, Terms and Phrases, giving a brief meaning of all which are in common use.

EXTRACTS OF A FEW OF THE HUNDREDS OF LETTERS ON FILE

Geo. E. Hanscom, Electrical Department Mare Island Navy Yard, says: "Send two more copies of Practical Electricity. Find this work invaluable. I guess my friends do also as they never let a chance to steal them escape. I am having chains made to attach them to my desk."

Herbert W. Kimble, Electrician, Haverhill, Mass., says: "I saw in Dartmouth College Library a copy of Practical Electricity. I was so much pleased with it I want a copy."

L. D. Burlingame, Pasadena, Cal., says: "In a trip to Arizona I lost my copy of Practical Electricity. I prize the book so highly that I enclose money order for another."

Wm. Hickey, Sec'y Electrical Workers' Union No. 49, Chicago, Ill., says: "This book is a little wonder. Every Question and Answer is given so plainly that any one can understand them. It is not only instructive to beginners, but to those advanced as well."

Camble Courtney, Newry, S. C., says: "I know nothing about Electricity yet your book gives a great deal of valuable information, it is written in such a common sense way."

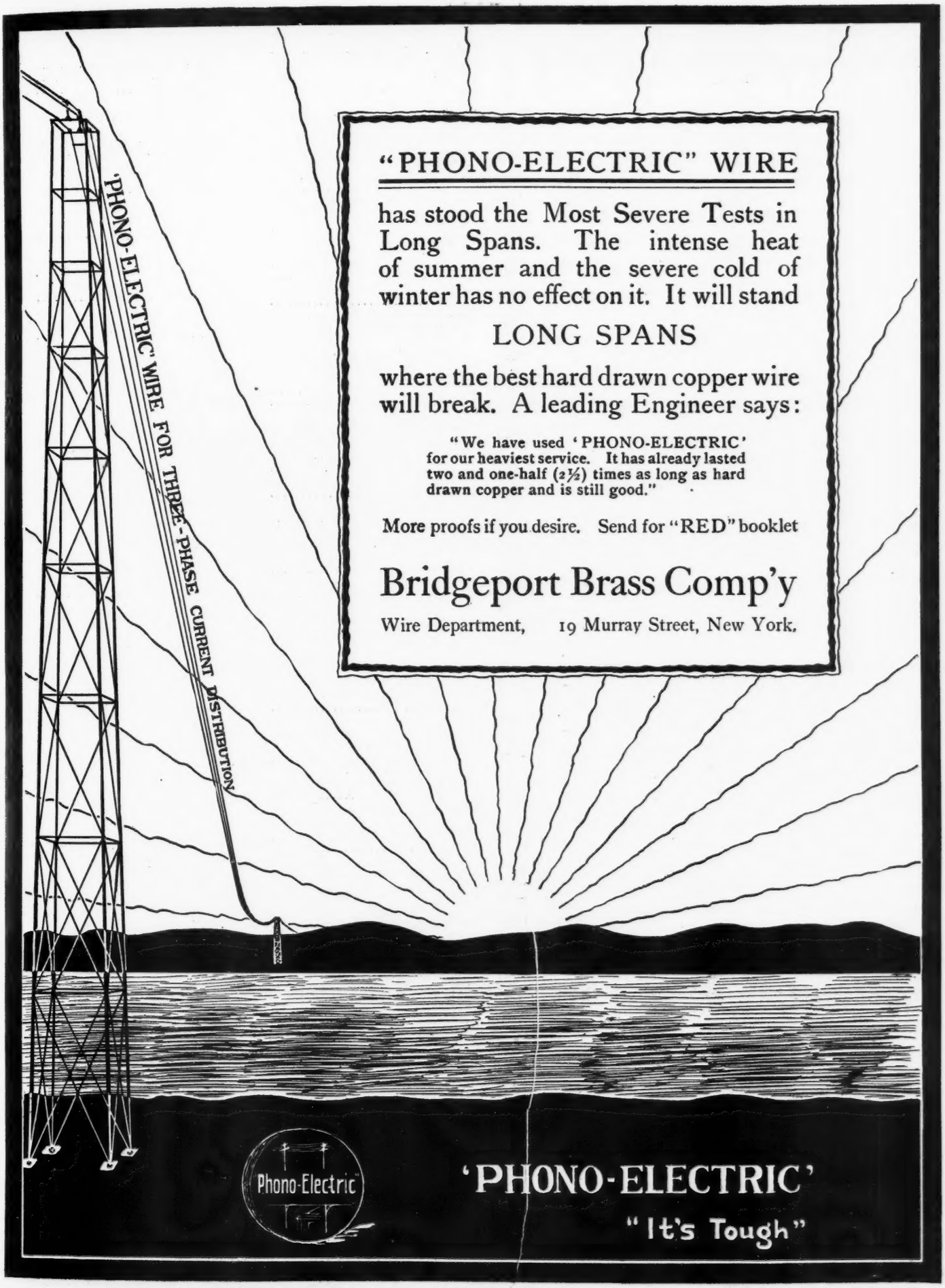
Lewis P. Osborn, Warden, Idaho, says: "Mr. Livingston, Chief Electrician of the light plant at Bozeman, Mont., gave me a copy of your book while I was in his employ. I lost it in a hotel fire; find money order for another copy."

James H. Kendle, Marine Engineer, Detroit, Mich., says: "I purchased your book from Burrows Bros. of your city. I think so much of the book. I have quite a library of books and have none I think more of than Practical Electricity.

Third Edition. **Price $2.00, Delivered.**

ELECTRICAL REVIEW PUBLISHING CO.

Box 339. **13-21 Park Row, New York.**


"PHONO-ELECTRIC" WIRE
has stood the Most Severe Tests in Long Spans. The intense heat of summer and the severe cold of winter has no effect on it. It will stand
LONG SPANS
where the best hard drawn copper wire will break. A leading Engineer says:
"We have used 'PHONO-ELECTRIC' for our heaviest service. It has already lasted two and one-half (2½) times as long as hard drawn copper and is still good."
More proofs if you desire. Send for "RED" booklet
Bridgeport Brass Comp'y
Wire Department, 19 Murray Street, New York.
'PHONO-ELECTRIC' WIRE FOR THREE-PHASE CURRENT DISTRIBUTION
Phono-Electric
'PHONO-ELECTRIC'
"It's Tough"

Sometimes

a central station manager thinks he sees a bargain in a new lighting transformer at a low introductory price or with a unique and tempting special guarantee and he buys a few on suspicion

Everytime

he does this he takes chances of getting a poorly designed and crudely constructed transformer and also of finding a string tied to the guarantee with one end in the hands of an irresponsible maker. And he then has one more style of transformer to keep in good condition

Anytime

he decides to place all his orders with one old and reliable transformer manufacturer, he has made a long stride toward systematic methods and increased earnings for his station, and when he selects Type A "WOOD" Transformers he gets good service not only **sometimes** but **anytime** and **everytime**

Many managers have proved this to their own satisfaction. We would like to discuss the matter with YOU

Fort Wayne Electric Works

Fort Wayne, Ind.

Chicago Office, 623 Marquette Bldg. W. S. GOLL, Manager

142

INDEX TO ADVERTISERS.

A

Abbott, Eugene B. 85
Adams-Bagnall Electric Co.
Akron Electrical Mfg. Co. 30
Allen & Co., L. B. 66,67
Allis-Chalmers Co. 85,90
Alphaduct Mfg. Co. 85
American Battery Co. 70
American Bell Telephone Co. 94
American Carbon & Battery Co.
American Circular Loom Co. 11
American Conduit Co. 25,46
American District Steam Co. 87
American Electrical Heater Co. 30
American Electric Telephone Co. 95
American Electrical Works 1
American Engine Co. 85,91
American Insulated Wire & Cable Co. 100
American Platinum Works 53
American Push Button Telephone Co. 47
American Steel & Wire Co. 10
American Vitrified Conduit Co. 24
Arnold Electric Power Station Co. 93
Ashcroft Mfg. Co. 83
Atlantic Insulated Wire & Cable Co. 86
Atwater Kent Mfg. Works
Automatic Electric Co 47,95
Automatic Time Stamp Co. 97

B

Babcock & Wilcox Co. 87
Baker & Co. 70
Baker & Co., W. E. 93
Baker, Jos. B. 93
Ball & Wood Co. 85
Banner Electric Co. 49
Barnes Co., The Wallace.
Barron & Co., Jas. S. 83
Barstow, W. S. 93
Bates & Bro., D. L. 37
Bell Telephone Mfg. Co. 95
Benson & Co., William W. 24
Biddle, James G. 83
Big Four R. R. 42
Billings & Spencer Co.
Bishop Gutta-Percha Co 1
Blake, M. J. & M. 36
Bossert Electric Construction Co. 85
Boston Electric Co. 83
Brady, T. H. 87
Bridgeport Brass Co. 1,51
Bristol Co. 1
Brixey, W. R. 16
Brookfield Glass Co. 84
Browning Mfg. Co. 31
Bryan-Marsh Co.
Bullock Electric Mfg. Co. 64
Bunnell & Co., J. H 4
Bureau of Expert Investigation and Construction. 93
Burnley Battery & Mfg. Co 64

C

Cahoon, James Blake. 93
Camp, W. M. 44
Camp Co., H. B. 25
Cary Spring Works. 6
Case Bros 84
Central Electric Co. 3
Chicago Edison Co. 30
Chicago Fuse Wire Mfg. Co.
Chicago Insulated Wire Co. 100
Chicago, Milwaukee & St. Paul Ry. 87
Christensen Engineering Co. 29
Cleveland Armature Works.
Coho & Co., H. B. 37
Coleman Mfg. Co., The.
Collins, A. Frederick. 93
Collyer Insulated Wire Co. 10
Columbia Incandescent Lamp Co.
Columbia Electric & Mfg. Co. 87
Consolidated Engine-Stop Co
Consolidated Railway Electric Lighting & Equipment Co. 36
Consolidated Safety Valve Co.
Consumers' Carbon Co. 6
Continuous Rail-Joint Co. of America. 6
Corson, Wm. R. C. 93
Crescent Insulated Wire and Cable Co. 100
Crocker-Wheeler Co. 33
Croselmire & Ackor. 87
Crouse-Hinds Electric Co 62,63
Cutler-Hammer Mfg. Co. 43
Cutter Co. 1

D

Dayton Electrical Mfg. Co. 22
Detroit & Buffalo Steamboat Co. 86

D

De Veau Telephone Mfg. Co. 95
Diamond Meter Co.
Dickey-Sutton Carbon Co. 6
Dielectric Mfg Co. 53
Diehl Mfg. Co. 36,38
Dixon, Jos., Crucible Co. 87
Donnelly, John. 86
Doubleday-Hill Electric Co. 64
Duncan Electric Mfg. Co. 4
Dustin Co., Chas. E. 88
Duvall, E. S., Jr. 83
D. & W. Fuse Co. 3

E

Eck Dynamo & Motor Works. 30
Eccleston Lumber Co. 96
Economical Electric Lamp Co. 28
Edison Decorative & Miniature Lamp Department. 70
Edison Mfg. Co. 20,40
Elblight Co. of America. 67
Electric Appliance Co. 1
Electric Cable Joint & Appliances Co. 57
Electric Contract Co. 46
Electric Gas Lighting Co.
Electric Motor & Equipment Co. 5,85
Electric Storage Battery Co. 19,53
Electric Launch Co. 53
Electrical Engineer Institute of Correspondence Instruction. 87
Elwell-Parker Electric Co. 20
Empire Wire Co. 66,100
Ericsson Telephone Co. 100
Eureka Electric Color Co. 42
Ewing-Merkle Electric Co.
Eyanson & Co., Geo. T. 6

F

Farr Telephone & Construction Supply Co 95
Fahnestock Transmitter Co. 96
Feilden Publishing Co., Ltd. 4
Field C. J. 24,93
Fleming Slate Co. 86
For Sale.
Fort Wayne Electric Works. 52
The Fostoria Incandescent Lamp Co. 17
Fowler, John H. 96
Franklin Model Shop.
Frink, I. P. 100

G

General Electric Co. 26,27
General Incandescent Arc Light Co. 36
Gest, G. M. 23
Gould Storage Battery Co. 21
Graton & Knight Mfg. Co. 84
Green Fuel Economizer Co. 92

H

Hanchett, Geo. T. 93
Hancock Inspirator Co
Harrisburg Foundry & Machine Works. 91
Hartford Steam Boiler Inspection & Insurance Co. 87
Hart & Hegeman. 65
Hart Mfg. Co. 6,21
Hayden & Derby Mfg. Co.
Hazard Mfg. Co. 10
Helios-Upton Co.
Hemingray Glass Co. 41
Hill, W. S., Electric Co. 24
Hobart Electric Mfg. Co. 1
Holophane Glass Co. 44
Hubbell, Harvey 44
Hungerford Electric Mfg. Co. 8
Hunt Co., C. W. 86
Hunter Fan & Motor Co. 36

I

Incandescent Electric Light Manipulator Co.
Independent Incan. Lamp Co. 68,69
India Rubber & Gutta Percha Insulating Co 8,10
International Correspondence Schools
Inventive Age Publishing Co. 85

J

Jeffrey Mfg. Co. 87
Jewell Electrical Instrument Co. 53
Johns-Manville Co., H. W. 5
Johnson, Chas. F. 84
Jones & Son, J. 83

K

Kellogg Switchboard and Supply Co. 97

(Continued on page 56.)

WHITNEY INSTRUMENTS

PORTABLE

**OHM-
WATT-
VOLT-
AMPERE-
METERS**

For Direct and Alternating Current

REASONABLE PRICES AND UNSURPASSED ACCURACY

Send for New Catalogue

MACHADO & ROLLER
203 BROADWAY, N. Y. CITY
General Sales Office of Whitney Electrical Instrument Co.

QUALITY COUNTS

That is why we are receiving more orders than ever before; that is why Wheeler Shades are specified in preference to all others; and that is why the buyer is willing to pay us a higher price.

WHEELER REFLECTOR CO.
156 PEARL STREET, BOSTON
Foreign Department, 120 Liberty Street, New York City

Voltmeters, Ammeters, and Volt-Ammeters . . .

POCKET SIZE,
VARIOUS RANGES,
ACCURATE,
RELIABLE.

For General Measurements, Testing Storage and Primary Batteries, Circuits, Etc.

L. M. PIGNOLET,
Manufacturer of ELECTRIC INSTRUMENTS, and ELECTROTHERAPEUTIC APPARATUS.
78 Cortlandt Street, New York.

PLATINUM

IN SHEET OR WIRE FOR ALL PURPOSES

SCRAP PURCHASED.

AMERICAN PLATINUM WORKS,
Formerly CHARLES F. CROSELMIRE. 251 to 255 New Jersey R. R. Ave. NEWARK, N. J.

FOR CONTINUED CONTACT WITH COPPER — CHEMICALLY INERT

DIELECTROL

COIL CEMENT — DIELECTRIC MNFG. CO. SAINT LOUIS

JEWELL INSTRUMENTS

For Direct Current only, are used by discriminating engineers

Our Laboratory Instruments are made to ensure the maximum of accuracy and convenience, and have long, open, easily read scales.

Laboratory Instruments

Jewell Electrical Instrument Company
61 and 63 Union Park Court, cor. Carroll Ave. - CHICAGO, Ill., U. S. A.

REG. TRADE MARKS

THE PHOSPHOR BRONZE SMELTING CO. LIMITED,
2200 WASHINGTON AVE., PHILADELPHIA.
"ELEPHANT BRAND PHOSPHOR-BRONZE"
INGOTS, CASTINGS, WIRE, RODS, SHEETS, ETC.
— DELTA METAL —
CASTINGS, STAMPINGS AND FORGINGS.
ORIGINAL AND SOLE MAKERS IN THE U.S.

ELECTRIC LAUNCHES

A PAYING INVESTMENT AT PARKS AND PLEASURE RESORTS

Can't Explode

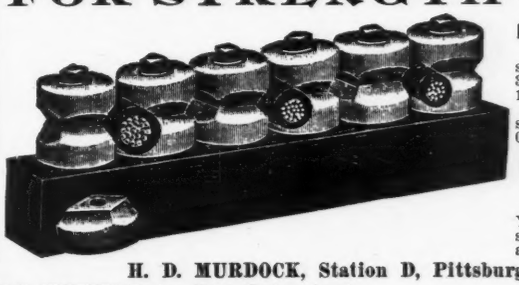
SIMPLE IN CARE — RELIABLE IN OPERATION

No Heat - No Smoke - No Smell

THE ELECTRIC LAUNCH COMPANY
Avenue A and North Street
BAYONNE CITY, N. J.

FOR STRENGTH

USE MURDOCK CABLE INSULATORS



Size A holds all sizes of cables from 300,000 C. M. to 1,000 000 C. M.
Size B holds all sizes of cables from 00 to 300,000 C. M.

100,000 SOLD

Your dealer can supply you or address

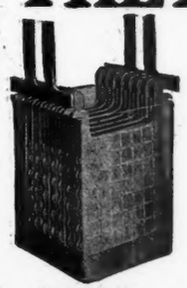
H. D. MURDOCK, Station D, Pittsburg
C. S. KNOWLES, Boston, Mass., Eastern Agent

THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA

MANUFACTURER OF THE

"Chloride Accumulator"



For Central Stations, Electric Railways, Isolated Lighting and Power Stations, Fire Alarm, Telegraph, Train Lighting, etc., etc.

PRICE LISTS AND DESCRIPTIVE BULLETINS FORWARDED UPON REQUEST

— SALES OFFICES —

PHILADELPHIA: Allegheny Ave. & 19th St.
NEW YORK: 100 Broadway
BOSTON: 60 State Street
CHICAGO: Marquette Bldg.
BALTIMORE: Continental Trust Bldg.
ST. LOUIS: Wainwright Bldg.
SAN FRANCISCO: Nevada Block
CLEVELAND: Citizens Bldg.
HAVANA CUBA: G. F. Greenwood, Manager 34 Empedrado Street

MAGNETIC SUSPENSION
STANLEY
RECORDING WATTMETERS

NO WEAR.
NO FRICTION.
NO REVENUE LOST.

RECORDS ALL CURRENT USED.

WRITE FOR BOOKLET "ABOUT METERS"

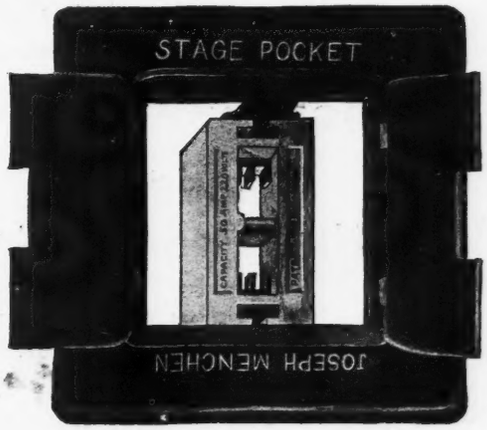
STANLEY INSTRUMENT CO.
GREAT BARRINGTON, MASS.

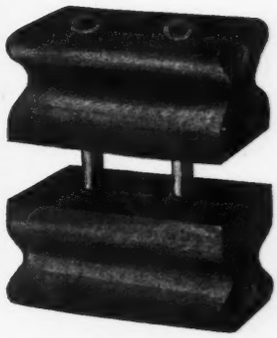
European Office: 23 Boulevard des Italians, Paris.

SALES AGENTS
FOR PACIFIC COAST—JNO. MARTIN & CO., San Francisco, Cal., Los Angeles, Cal., and Seattle, Wash.
FOR COLORADO, IDAHO, MONTANA, NEW MEXICO and WYOMING—THE HENDRIE & BOLTHOFF M'F'G & SUPPLY CO., Denver, Col.
FOR MEXICO—VICTOR M. BRASCHI & BRO., Mexico City

My Improved Electrical Theatrical Appliances

Used by nine-tenths of the New York Theatres





Menchen Stage Receptacle and Attaching Plug

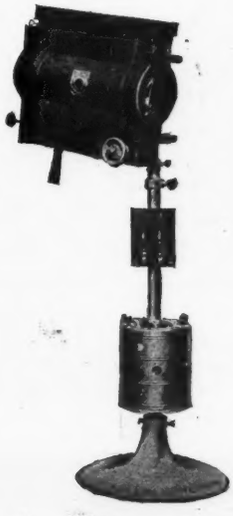
The design of these new Stage Receptacles is considered the most practical ever offered to the trade. The containing box and cover are of cast iron and the base supporting contacts is of glazed porcelain, thus rendering them absolutely free from moisture.

The inner wall prevents the pocket from being short-circuited. The pockets are open at top and bottom so as to allow any foreign substance that may enter to fall through. The entire body of the pocket is made of solid porcelain three-quarters of an inch thick.

They can not change polarity, as the plug can go in only one way.

The Menchen Attaching Plug

Made of the highest grade of vulcabeston. Especially suited for connections which have to be made and unmade frequently and rapidly. Adapted for theatrical work, for *storage battery connections in automobiles*, coupling on electric railways, etc. Made in any capacity up to fifty amperes.



THEATRICAL LAMPS, OPTICAL LANTERNS AND ACCESSORIES.

Joseph Menchen,

MANUFACTURER & PATENTEE.

1237 BROADWAY, NEW YORK CITY (N.Y.)

Lawrence-Hall Electric Co.

CINCINNATI, OHIO

MANUFACTURERS' AGENTS & JOBBERS OF

ELECTRICAL SUPPLIES

213 WEST FOURTH STREET. TELEPHONE M 3326.

Okonite Wires
Okonite Tape
Manson Tape
Candee
Weather-Proof Wires

OKONITE TRADE MARK.

IN STOCK FOR PROMPT SHIPMENTS
IF YOU APPRECIATE GOOD "SUPPLY HOUSE SERVICE" TRY US

WRITE US FOR PRICES ON WHAT YOU WANT

DEACON-BROOKS CO. INDPLS.

ALPHABETICAL INDEX.—(*Continued from page 52.*)

K

Kinsman Electric and Railway Supply Co 3
Klein & Sons, Mathias 96
Knott Apparatus Co., L. E. 30
Knowles, Edward R. 93

L

Lamp Testing Bureau 83
Lawrence Hall Electric Co 56
Leffel & Co., James 60
Le Valley Vitae Carbon Brush Co.
Lombard Governor Co 60
Lowell Model Co 84
Lunkenheimer Co 100
Lyndon, Lamar 93
Lyon Metallic Mfg. Co 30

M

Machado & Roller 53
Magnet Wire Co 1,44
Manhattan Electrical Supply Co. 86
Marshall, Wm 84
Marshall-Sanders Co. 28
Massachusetts Chemical Co 9
McGill University 42
McIntire Co., The C 36
McTighe, Thos. J 93
Mead Cycle Co 87
Mechanical Boiler Cleaner Co .....
Menchen, Joseph P 42,55
Mica Insulator Co .....
Michigan Central R.R 34
Michigan College of Mines 42
Michigan Electric Co 86
Monarch Fire Appliance Co 28
Montauk Fire-Detecting Wire Co. 1
Morse Twist Drill Co 30
Munsell & Co., Eugene 70
Murdock, H. D 53
Murdock Parlor Grate Co 30

N

Nassau Light & Power Co 86
National Battery Co 20
National Carbon Co .....
National Conduit & Cable Co 1
National India Rubber Co 1
Nernst Lamp Co 98
New England Butt Co 10
New England Engineering Co 5,93
New England Motor Co 30
New Process Raw Hide Co 85
New York & Ohio Co .....
New York Cen. & Hudson Riv. R.R.
New York Insulated Wire Co 1
New York Telephone Co 95
North Electric Co 94

O

Okonite Co 1,12,13,14,15
Osborn-Morgan Co 36
Osburn Flexible Conduit Co 1
Ostrander, W. R. & Co 42
Otis Elevator Co 36,45

P

Pacific Electric Co 28
Pairpoint Corporation .....
Paiste Co., H. T 64
Parsell & Weed 42
Pennsylvania R. R 44
Phelan, D. W 96
Phœnix Glass Co 1
Prometheus Electric Co 59
Phelps Co 61,86
Phillips, Eugene F., Bare and Insulated Wires 1
Phillips Insulated Wire Co 100
Phosphor-Bronze Smelting Co 53
Pignolet, Louis M 53
Portland Co., The .....
Power Installation Co 93
Powers Co., The E. L 93
Prentiss Clock Improvement Co 42
Pullen Electric Co., Leon W 6

R

Rae, Frank B 93
Rappel, E. F. P 87
Reuterdahl, Arvid 93
Reuterdahl Electric Co 20
Risdon-Alcott Turbine Co 60
Rittenhouse-Miller Co 24
Robbins & Myers Co 37
Robe Fibre Pulley Covering Co 83
Robertson & Sons, Jas. L 84
Roebling's Sons Co., John A 100
Rooney-Westbury Elec. Lamp Co. 84
Rose Polytechnic Institute 42
Rosenberg Co., E .....
Rossiter, MacGovern & Co 89
Runyon, F. O 93
Russell Tomlinson Elec Co 94

S

Safety Insulated Wire & Cable Co. 10
Samson Cordage Works 84
Schapirograph Co. 84
Schwerdtle Stamp Co 86
Shelby Electric Co 1,20,86
Siggers & Siggers 83
Sills-Eddy Mica Co 6
Simplex Electrical Co 1
Simplex Electric Heating Co 84
Smith Storage Battery Co 20
Smith & Hemenway Co 100
Speer Carbon Co 100
Sprague Electric Co 39,70

(*Continued on page 60.*)

MAGNETIC SUSPENSION

STANLEY RECORDING WATTMETERS.

NO WEAR
NO FRICTION.

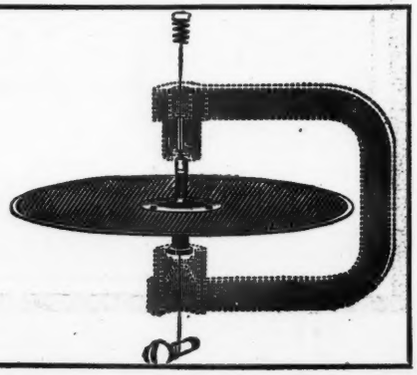
NO REVENUE LOST.
ALL CURRENT USED RECORDED.

Send for description and book full of good information

"ABOUT METERS."

STANLEY INSTRUMENT CO., Great Barrington, Mass., U. S. A.
EUROPEAN OFFICE, 23 Boulevard des Italiens, Paris, France.

SALES AGENTS
FOR PACIFIC COAST—JNO. MARTIN & CO., San Francisco, Cal., Los Angeles, Cal., and Seattle, Wash.
FOR COLORADO, IDAHO, MONTANA, NEW MEXICO and WYOMING—THE HENDRIE & BOLTHOFF M'F'G & SUPPLY CO., Denver, Col.
FOR MEXICO—VICTOR M. BRASCHI & BRO., Mexico City

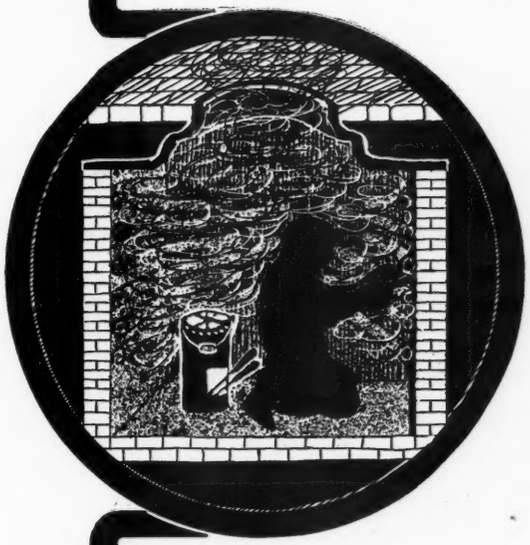


A Perfect Electrical Cable Joint

No Solder—No Ruined Insulation—No High Resistance Air-Gaps. A Positive Contact Assured. Easy of Application. Will Never Break Down nor Come Apart

Fig. 1.

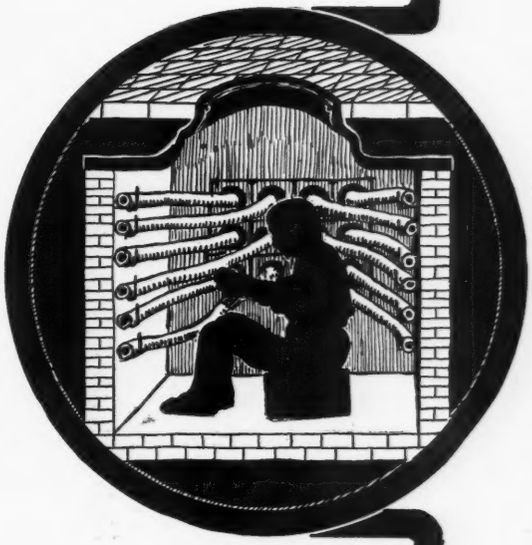
THE DOUBLE CONICAL EXPANSION JOINT



THE OLD WAY

THE EXPANSION PLUG TERMINAL

The cable is inserted in the tapered thimble and drawn into positive contact by means of the flanged outside sleeve.



THE NEW WAY

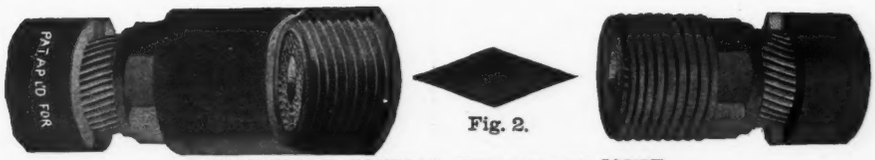


Fig. 2.

THE DOUBLE CONICAL EXPANSION JOINT

The cable is inserted into the tapered thimble, and a hole is started in the cable by a nail or a "centre punch," the ends of the conical wedge are then put in place and the external flanged and threaded sleeves are drawn together, forcing the soft copper plug into a homogeneous mass which carries all the current with no increase in resistance.

THE ELECTRIC CABLE JOINT AND APPLIANCES CO.

PARK ROW BUILDING. NEW YORK CITY

ELECTRICAL REVIEW

Third Edition Revised

Pocket Size, Flexible Leather, 1,000 Pages, with innumerable Diagrams, Illustrations and Tables. Price, $5.00.

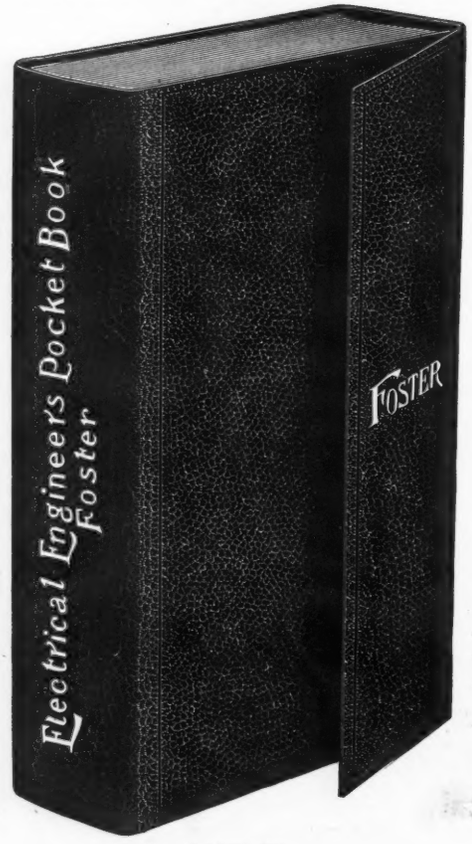
Electrical Engineer's Pocketbook

The most complete book of its kind ever published, treating of the latest and best practice in Electrical Engineering.

By HORATIO A. FOSTER

Member Amer. Inst. E. E., Member Amer. Soc. M. E.

(With the Collaboration of Eminent Specialists)



⅝ Actual Size

CONTENTS

Electrical Engineering Symbols. Electrical Engineering Units. Description of Instruments. Resistance Measurements. Measurement of E. M. F. Measurement of Capacity. Measurement of Inductance. Measurement of Power on Alternating Current Circuits. Tests with Voltmeter. Determination of Magnetic Properties of Iron and Steel. Determination of Wave Form of E. M. F. and Current. Conductors, Properties of. Conductors, Relation and Dimensions of, for Transmission of Electric Current. Transmission of Power. Switchboards and Switching Devices. Cable Testing. Electromagnets. Dynamos. Motors. Testing Dynamos and Motors. Static Transformers. Electric Lighting. Electric Railways. Storage Batteries. Telegraph. Telephone. Electro-Chemistry. Electro-Metallurgy. Electric Heating, Welding and Cooking. Electricity Meters. Lighting Arresters. Lightning Conductors. National Code Rules and Requirements. Miscellaneous Electrical Data. Certain Uses of Electricity in U. S. Army and Navy. Mechanical Section. Index.

Just Published

8vo, Cloth, 259 Pages, Illustrated. Price, $2.50 net

(Binding, Uniform with authors' "Dynamo Electric Machinery.")

Alternating Current Machines

Being the Second Volume of

"Dynamo Electric Machinery;

Its Construction, Design and Operation"

By

SAMUEL SHELDON, A. M., Ph. D.

Professor of Physics and Electrical Engineering at the Polytechnic Institute of Brooklyn

And

Hobart Mason, B. S., E. E.

Previously Published

8vo, Cloth, 281 Pages, Profusely Illustrated. Price $2.50 net

Fourth Edition Revised

Dynamo Electric Machinery;

Its Construction, Design and Operation

By

SAMUEL SHELDON, A. M., Ph. D.

Professor of Physics and Electrical Engineering, Polytechnic Institute of Brooklyn

Assisted by

Hobart Mason, B. S.

Direct Current Machines

D. Van Nostrand Company

Publishers and Booksellers **23 Murray and 27 Warren Streets, New York**

Copies sent prepaid on receipt of price

CENTRAL STATION MANAGERS!!

Make a bid for a Heating and Cooking Load. It may burst your wattmeter and break records, but will make customers and money

Send for complete Heating and Cooking Catalogue of

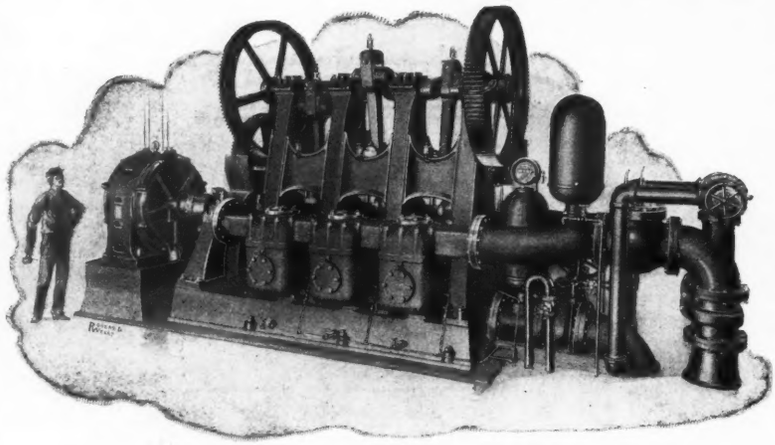
THE PROMETHEUS ELECTRIC CO.

39 CORTLANDT STREET, - - - NEW YORK

TIME
HAS DECIDED THE SUPERIORITY OF THE
STAR
Incandescent
Lamp.
Not made by trust or combine, but produced by an independent concern engaged in building up a business on the merits of its goods.
We want your orders not your contracts.
The STANDARD ELECTRICAL MFG. CO.
NILES O.
SWEENEY-CLEVE.O

The Smith-Vaile Electric Triplex Pumps

Afford an excellent means for pumping water for House Service, Hydraulic Elevator Service, Factories and Mills desiring an independent water supply; also for Mine Work and WATERWORKS SUPPLY. Can be located wherever electric current is available, and require little or no attention after once installed.



Smith-Vaile Triplex Electric Pump, City of Rock Island, Ill., Capacity, 2,000,000 Gallons per 24 Hours

These Pumps are modern throughout
Compact, strong, and all strains are
Concentrated within small areas
Further particulars freely furnished
We also make

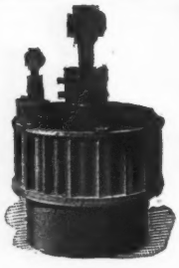
Steam and Power Pumping Machinery for all Purposes

Jet and Surface CONDENSERS, FEED WATER HEATERS and

VICTOR TURBINE WATER WHEELS

The Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio, U. S. A.

NEW YORK: 141 Broadway PHILADELPHIA: 619 Arch St. CHICAGO: 311 Dearborn St. BOSTON: 73 Oliver St. SAN FRANCISCO: 11-13 First St.
NEW ORLEANS: 304 Hennen Building CLEVELAND: 1116 New England Building BALTIMORE: 1507 Continental Trust Building
(2) Sales Agents: FREDERIC NELL, 97 Queen Victoria Street, London, England E. F. AUSTIN, Smith Block, Pittsburg



TURBINES

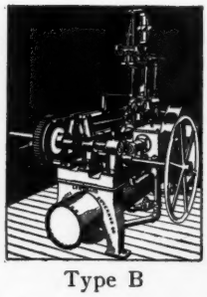
UPRIGHT AND HORIZONTAL
For ELECTRIC POWER and LIGHTING PLANTS

RISDON TURBINE
gives the highest full gate results of any Turbine ever made.

ALCOTT HIGH DUTY TURBINE
High speed and efficiency. Great strength. Close regulation and steady motion.

TAYLOR SLEEVE GATE TURBINE
The largest power ever obtained from a wheel of the same diameter.

RISDON - ALCOTT TURBINE CO.
Write for Catalogue. MOUNT HOLLY, NEW JERSEY, U. S. A.



Type B

OUR
Water Wheel Governors
ARE THE
Standard of the World

Twelve types controlling 400,000 horse-power are in use.
Write for catalogue and list of several hundred plants where they are in use.

The Lombard Governor Co.
36 WHITTIER ST., BOSTON, MASS.

ALPHABETICAL INDEX.

(*Continued from page 56.*)

S

Standard Electric Mfg. Co.....28,59
Standard Paint Co..... 70
Standard Pole & Tie Co..... 96
Standard Underground Cable Co.. 1
Standard Vitrified Conduit Co..... 25
Stanley Electric Mfg. Co..... 1
Stanley Instrument Co 54,56
Stanley & Patterson..... 6
Stanton, Le Roy W..... 93
Star Porcelain Works..... 83
Sterling Electrical Mfg. Co..... 28,61
Sterling Varnish Co.. 70
Stevens, Horace J..... 86
Stilwell-Bierce & Smith-Vaile Co.. 60
Stirling Co..... 87
Stow Manufacturing Co..... 31
Stromberg-Carlson Telephone Mfg. Co..... 97
Stuart-Howland Co..... 61
Swedish-American Telephone Co.. 95

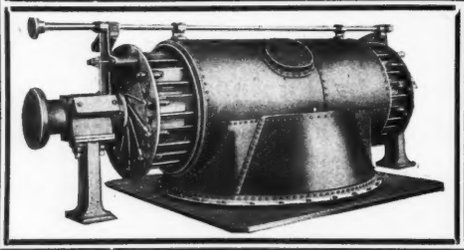
T

Thresher Electric Co..... 32
Toomey, Frank..... 85
Triumph Electric Co..... 34
Tulley & Co., Henry C..... 37

U

United Electric Heating Co..... 61
U. S. Battery Co..... 1
U. S. Mineral Wool Co. 30

SAMSON TURBINE



HIGH EFFICIENCY at reduced gateage, QUICK SPEED and GREAT POWER are the three essential points demanded of a turbine driving No. 63 GENERATOR. No other turbine maintains these three points to such a high degree of perfection as the SAMSON. Write Dept. V. for Catalog.

JAMES LEFFEL & CO., Springfield, Ohio, U. S. A.

U

University of Wisconsin..... 42
Utica Drop Forge & Tool Co..... 100

V

Vail, J. H..... 93
Valentine-Clark Co..... 96
Van Nostrand Co., D 58
Viaduct Mfg. Co..... 95
Vindex Electric Co..... 84
Vought-Berger Co..... 95

W

Waclark Wire Co..... 10
Wagner Electric Mfg. Co..... 5
Wanted..... 86
Warren Electric Mfg. Co..... 31
Warren Electric & Specialty Co.. 1
Westcott, Geo. F..... 93
Western Electric Co..... 7
Western Electrical Supply Co....
Western Telephone Mfg. Co..... 95
Westinghouse Air Brake Co..... 2
Westinghouse Electric & Mfg. Co. 99
Weston Electrical Instrument Co.. 70
Wheeler Reflector Co..... 53

W

White & Co., J. G..... 93
White Star Appliance Co..... 44
Whitney Electrical Inst. Co 58
Wilmerding, C. H..... 93
Wirt Electric Co..... 43
Wyckoff Pipe & Creosoting Co... 70

Y

Yost Electric Mfg. Co..... 43

Z

Zimdars & Hunt.....

(*Continued on page 64.*)

THE THREE GRACES!!

Faith, Hope and Charity, Graces three,
But the greatest of these is Charity!
First misplaced Faith and then Hopes that fall,
But Charity offers the best of all!

THE STERLING SPECIAL

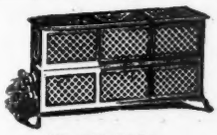
WRITE FOR CATALOGUE—PRICES—SAMPLES.

The Sterling Electrical Mfg. Co.

26 Cortlandt St., New York WARREN, OHIO. 57 Washington St., Chicago

---

ELECTRIC HEATING APPARATUS



IF YOU WANT THE BEST
WE CAN SUPPLY IT.
We make over 300 different devices

AIR HEATERS

UNITED ELECTRIC HEATING CO., 260 Randolph St., DETROIT, MICH.

STUART-HOWLAND CO.

Largest Line of RAILWAY, TELEPHONE and LIGHTING SUPPLIES in New England
4-5 WINTROP SQUARE and 261-287 DEVONSHIRE ST.
BOSTON

Keystone Measuring Instruments
The CUTTER CO., Philadelphia
I-T-E Circuit Breaker Engineers

Shelby Useful Light Lamps

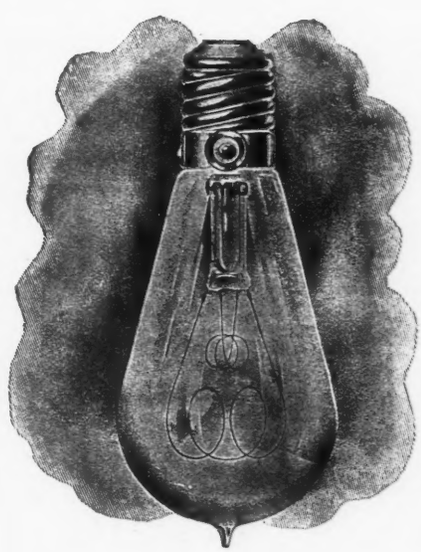
50 to 100% More Light Where You Want It the Most

BRANCH OFFICES IN ALL LARGE CITIES

THE SHELBY ELECTRIC COMPANY

100 Seco St., Shelby, Ohio

HYLO SELF-FLASHING SIGN LAMP . . .



Never goes out but flashes up and down about nine times a minute from the baby filament to the large filament, producing novel kaleidoscopic effects.

Will fit any ordinary lamp socket.

Practically weatherproof.

Maximum eye-catching quality with minimum first cost.

Saving in current and long life will pay difference in cost between a Hylo sign lamp and the common lamp.

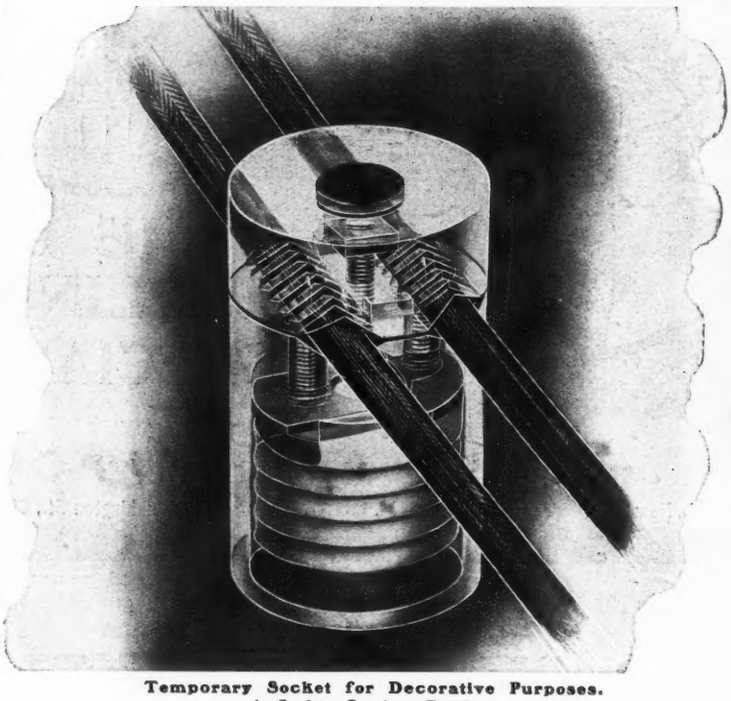
Edison base. Voltage 100 to 125.

Write for particulars, price and guarantees.

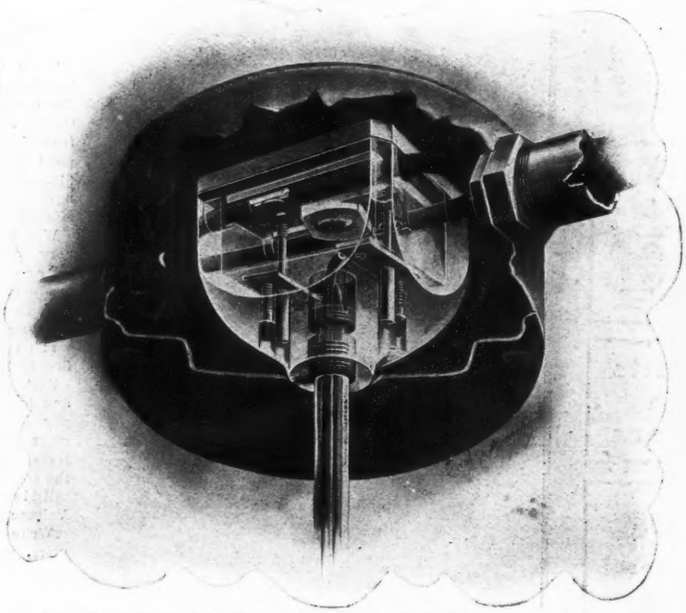
THE PHELPS COMPANY

29 Rowland Street, . . DETROIT, MICH.

For Electrical Enclosed Norbitt



Temporary Socket for Decorative Purposes.
A Labor-Saving Device.



Fuseless Bracket Rosette for Conduit Work. An entirely New Departure. Cap Interchangeable with Cap of Conduit and Sign Receptacle.

have been far and away the year for electricians, nothing in the

These Products Electrically and

They are put in place in a "jiffy" Even in a two-page advertisement the ADVANTAGEOUS features—to find a DISADVANTAGE—so send porcelain appliances.

Crouse-Hinds

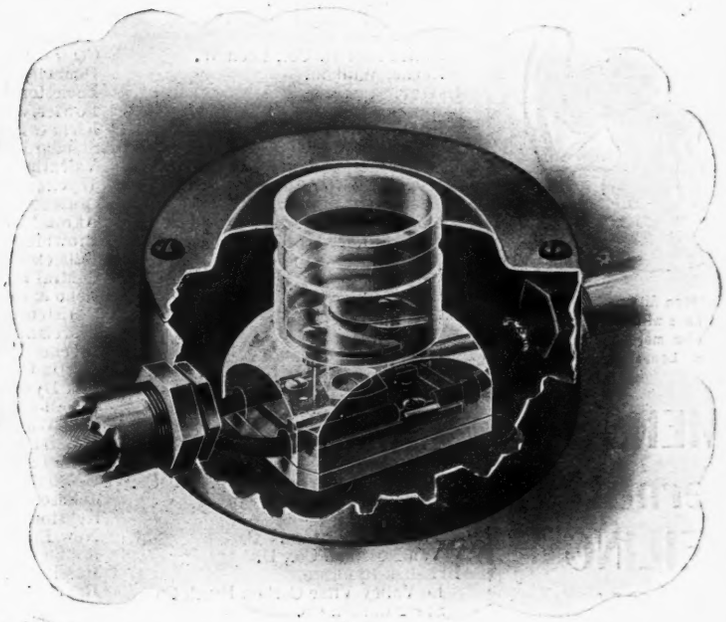
MAIN OFFICE
SYRACUSE,

Complete Stock at

NEW YORK, 23 Dey Street; BOSTON, 200 Clinton Street; CINCINNATI, SAN FRANCISCO,

Construction Contact Specialties

most important advance of the market has ever brought such a boon.



Permanent Conduit and Sign Receptacle

Are Perfect Mechanically

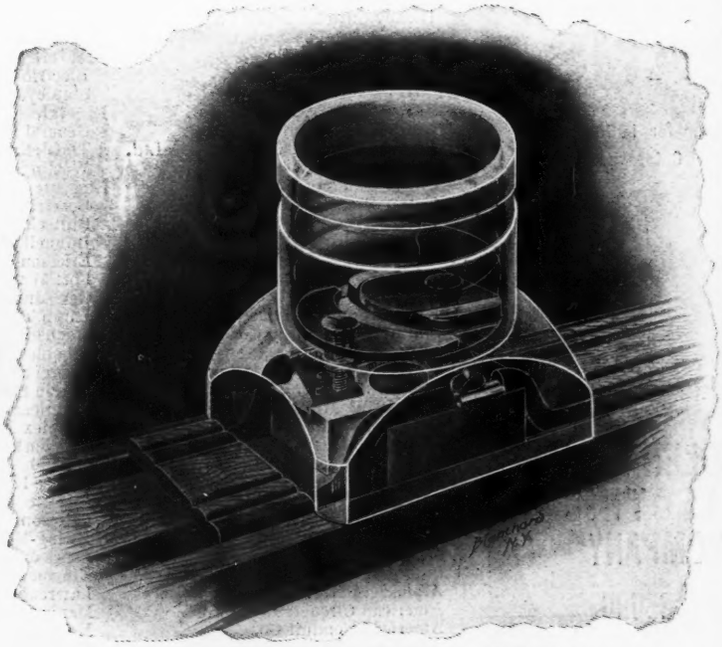
and are called the "quick-put-up." we cannot illustrate nor describe Our critics as yet have been unable for our complete new catalogue of

Electric Co.

AND WORKS
N. Y., U. S. A.

all Branch Stores

Summer Street; CHICAGO, 133 South 234 West 4th Street; Mills Building.



Moulding Receptacle. No Exposed Contacts. Easily and Quickly Installed.

WHOLE-SALE ELECTRICAL SUPPLIES

Emerson Alternating-Current Fans will use less current and give more air than any other make. Lowest Market Price.

"EMERSON" Alternating CEILING DESK and EXHAUST FANS

Send for 1903 Fan Catalogue

DOUBLEDAY-HILL ELECTRIC COMPANY

PITTSBURG PA.

CLASSIFIED INDEX

(Continued from page 60.)

Adjusters, Incandescent Lamps.
Incan. Elec. Light Manipulator Co.
Pacific Electric Co.
Vought-Berger Co.

Air Compressors.
Stilwell-Bierce & Smith-Vaile Co.

Alternators.
Christensen Engineering Co.
Fort Wayne Electric Works.
General Electric Co.
Warren Electric Mfg. Co.
Westinghouse Electric & Mfg. Co.

Armature Repairs.
Cleveland Armature Works.

Batteries, Primary.
American Carbon & Battery Co.
Bunnell & Co., J. H.
Burnley Battery & Mfg. Co.
Edison Mfg Co.
Pullen Electric Co., Leon W.
Roche, William.

Batteries, Storage.
American Battery Co.
Dayton Electrical Mfg. Co.
Electric Storage Battery Co.
Gould Storage Battery Co.
National Battery Co.
Reuterdahl Electric Co.
Smith Storage Battery Co.
United States Battery Co.

Bells.
Ostrander & Co., W. R.

Belt Dressing.
Dixon Crucible Co., Joseph.

Boilers.
Allis-Chalmers Co.
Babcock & Wilcox Co., The.
Stirling Co., The.
Toomey, Frank.

Boiler Cleaners.
Mechanical Boiler Cleaner Co.

Boiler Insurance.
Hartford Steam Boiler Insp. & In. Co.

Books, Technical.
E. L. Powers & Co.
Tulley & Co., Henry C.
Van Nostrand Co., D.

Brushes-Dynamo.
Le Valley Vitae Carbon Brush Co.
Speer Carbon Co.

Cable Hangers.
Standard Underground Cable Co.

Cabling Machines.
New England Butt Co.

Carbons.
American Carbon & Battery Co.
Consumers' Carbon Co.
Dickey-Sutton Carbon Co.
General Incandescent Arc Light Co.
National Carbon Co.
Speer Carbon Co.

Castings.
Christensen Engineering Co.
New England Butt Co
Phosphor-Bronze Smelting Co., Ltd.

Circuit-Breakers.
Cutler-Hammer Mfg. Co.
Cutter Electrical & Mfg. Co.
Fort Wayne Electric Works.
Western Electric Co.

Cleaners, Incandescent Lamps.
Incan. Elec. Light Manipulator Co.

Climbers
Klein & Sons, Mathias.
Smith & Hemenway Co

Coal Handling Machinery.
C. W. Hunt Co.
The Jeffrey Mfg. Co.

Coal Mining Machinery.
General Electric Co.
The Jeffrey Mfg. Co.

Commutator Lubricant.
Allen & Co., L. B.

Commutator Segments.
Billings & Spencer Co.

Condensers (Electric).
Marshall, Wm.

Conduits.
Alphaduct Mfg. Co.
American Circular Loom Co.
American Conduit Co.
American Vitrified Conduit Co.
Camp Co., H. B.
Field, C. J.
Gest, G. M.
National Conduit & Cable Co.
Osburn Flexible Conduit Co.
Rittenhouse-Miller Co.
Sprague Electric Co.
Standard Vitrified Conduit Co.
Wyckoff Creosoting Co.

Conduit Benders.
Benson & Co., Wm. W.

Connectors
Smith & Hemenway Co.

Connectors and Terminals.
McIntire Co., The C.

Construction.
J. G. White & Co.
New England Engineering Co.

Construction Supplies.
T. H. Brady.

Cross-Arms, Brackets, Pins, Ties, Climbers, Etc.
Central Electric Co.
Donnelly, John.
Eccleston Lumber Co.
Fowler, John H.
Klein & Son, Mathias.
Standard Pole & Tie Co.
Valentine-Clark Co.
Wyckoff Pipe & Creosoting Co.

Dynamos and Motors.
Akron Electrical Mfg. Co.
Browning Mfg. Co.
Bullock Electric Mfg. Co.
Central Electric Co.
Coho & Co., H. B.
Christensen Engineering Co.
Cleveland Armature Works.
Crocker-Wheeler Co.
Dustin Co., Chas. E.
Eck Dynamo & Motor Works.
Elwell-Parker Electric Co.
Fort Wayne Electric Works.
General Electric Co.
Gen'l Incandescent Arc Light Co.
Hobart Electric Mfg. Co.
Johnson, Charles F.
Keystone Electric Co.
New England Motor Co.
Robbins & Myers Co.
Rossiter, MacGovern & Co.
Royal Electric Co.
Sprague Electric Co.
Stanley Electric Mfg. Co.
Stow Manufacturing Co.
Thresher Electric Co.
Triumph Electric Co.
Toomey, Frank.
Wagner Electric Mfg. Co.
Warren Electric Mfg. Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Electric Lighters.
Electric Contract Co.
Stanley & Patterson.

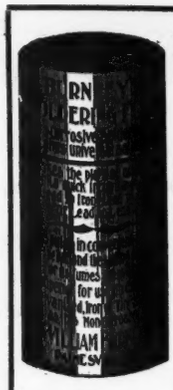
Electric Locomotives.
General Electric Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.

Electrical Instruments.
Bossert Electric Construction Co.
Bullock Electric Mfg. Co.
Bunnell & Co., J. H.
Ericsson Telephone Co.
Fort Wayne Electric Works.
Gen'l Incandescent Arc Light Co.
Lamp Testing Bureau.
Machado & Roller.
Pignolet, Louis M.
Wagner Electric Mfg. Co.

Electric Soldering Irons.
American Electrical Heater Co.
Simplex Electrical Co.

Electrical Supplies.
Central Electric Co.
Crouse-Hinds Electric Co.
Electric Appliance Co.
Ericsson Telephone Co.
Ewing-Merkle Electric Co.
Jones & Son, J.
Kinsman Electric & Railway Sup. Co
Lawrence-Hall Electric Co.
Manhattan Electrical Supply Co.
Marshall-Sanders Co.
Michigan Electric Co.
Paiste Co., H. T.
Stanley, Arthur F.
Stanley & Patterson.
Western Electric Co.

(Continued on page 98.)



QUICK AND GOOD WORK is the kind that BURNLEY SOLDERING PASTE (Patented) will help you to do. Put up in 2 oz., 4 oz., ½ lb., 1 lb., 5 lb., 10 lb. and 50 lb. packages.

Stick and Paste

The Burnley Battery and M'f'g Co.

Painesville, Ohio

DRY BATTERIES

Hawkins' New Catechism of ELECTRICITY

A Practical Treatise. Price $2.00.

Electrical Review Publishing Co.

13 Park Row, New York. Box 339.

Just specify "P-K"

For an Absolutely Safe

P-K

ATTACHMENT PLUG

All about these and our other 299 Time Savers in our new Catalog No. 10.

H. T. PAISTE CO.

Chicago Philadelphia New York

Another Reason

why Bullock Generators and Motors are best, is because they have laminated armature and pole cores. By this construction an exact knowledge of every part of the metal is obtained. No blow holes, sand or other defects in the metal of Bullock machines. Send for our descriptive bulletins.

Bullock Electric Mfg. Co., Cincinnati, U.S.A.

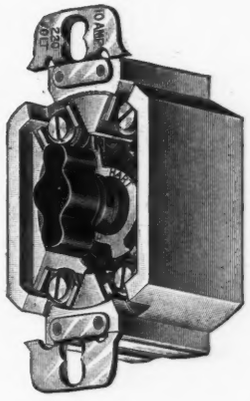
255

The "Hart"

Rectangular Base Flush Switches

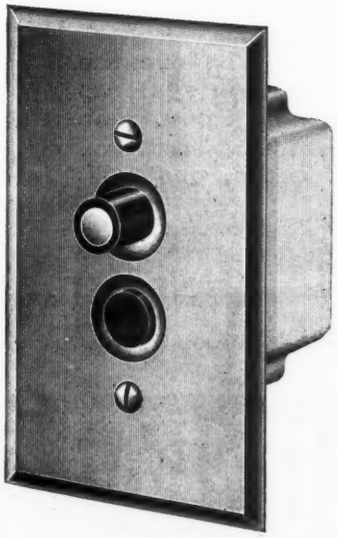
Switch Complete

No.	600.	5	Amp.,	S. P.,	220 Volts
"	601.	10	"	"	220 "
"	602.	10	"	D. P.,	220 "
"	603.	10	"	3-Way,	220 "
"	604.	10	"	4-Way,	220 "
"	605.	10	"	3-Section	Electrolier
"	609.	10	"	2 "	"



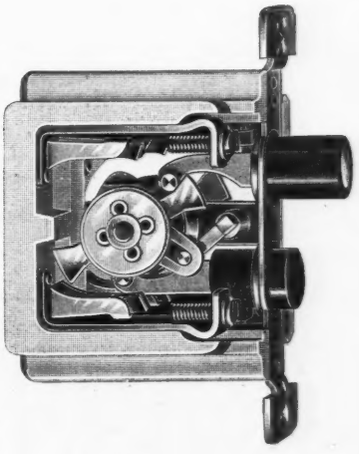
Illustrating Switch with Plate removed

The "H & H" Push Button Flush Switch



Switch Complete

No.	701.	10	Amp.,	S. P.,	110 Volts
"	702.	10	"	D. P.,	220 "
"	703.	10	"	3-Way,	110 "
"	704.	10	"	4-Way,	110 "



Illustrating Mechanism

THE HART AND HEGEMAN MFG. CO.

92 UNION PLACE, - - - - - - - - HARTFORD, CONN.

SAMPLE FREE!

THE ALLEN SOLDERING STICK (A FLUX)

MAKES SOLDER FLOW ON ANY METAL

"Officially approved by Underwriters' National Electrical Association."

TRY IT

L. B. ALLEN CO. INC.,
335 Columbia Ave., Chicago, Ill.

Power Plants of the Pacific Coast

A special edition of the paper read by Dr. F. A. C. Perrine before the New York Electrical Society descriptive of the great transmission systems of California. Includes illustrations of the great Carquinez Span, also fifty other illustrations.
Bound in boards, 8 1-4 inches by 10 3-4 inches. Price 50 cents, postpaid.

Address **Electrical Review Publishing Company**
13 PARK ROW NEW YORK
BOX 339

EMPIRE WIRE COMPANY

92 WILLIAM STREET NEW YORK
MANUFACTURERS OF
Bare and Tinned Copper and Magnet Wire
DON'T OVERLOOK INCREASED OUTPUT
INSPECTION AND TEST INVITED QUALITY
FACTORIES: ROME, NEW YORK :: :: :: :: LISBON, NEW HAMPSHIRE

Sign of the B-R Electric Co., Atlanta, Ga. Made of ELBLIGHT Cable and Lamps, on a 20 x 30-foot Light Steel Frame and suspended on the Flagpole of the Empire Building, 200 feet from the sidewalk. Plainly visible at a distance of 18 miles.

With ELBLIGHT CABLES any scheme of festooning, decoration or signs, for either inside or outside of buildings, can be easily carried out. ELBLIGHT LAMPS can be inserted with ease at any point in the cable.

Waterproof **Gasproof**

The only System of Decorative Lighting approved by the National Board of Fire Underwriters.

"Wherever you stick the lamp it lights."

Elblight Company of America

114 West Thirty-second Street, - New York

ELECTRICAL REVIEW

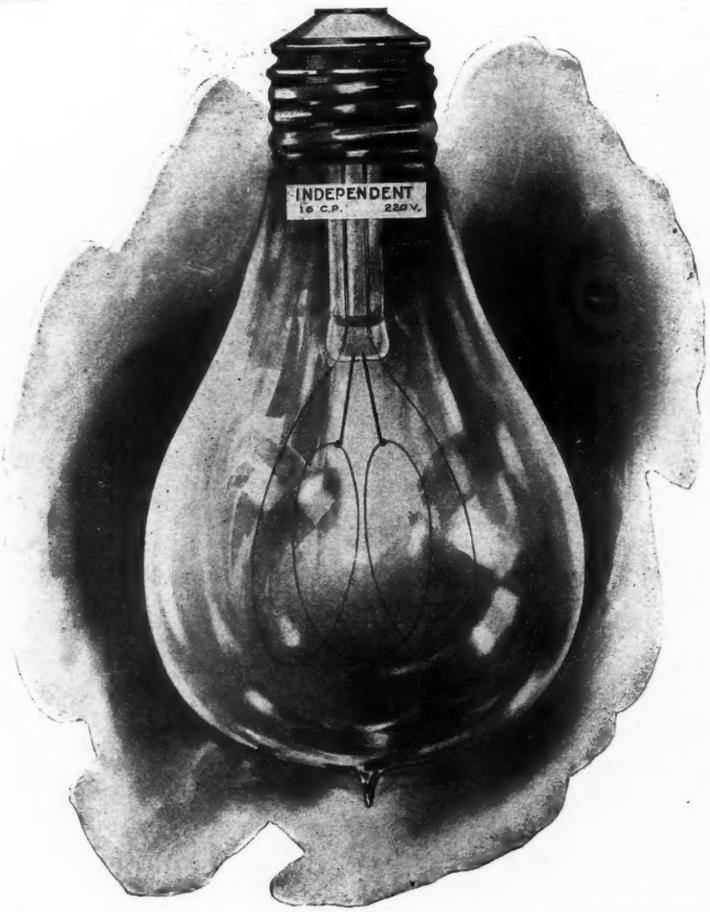
The Chip on his Shoulder

Independent—
And we are

Some Day Maybe

You'll let us fulfill our modest claims by giving us "that order," when you need lamps. They will go immediately on receipt of the order, and they will make a friend ot you. Another thing; your first order will be filled with the same kind of lamps you will get on subsequent orders.

No sample lots that regular shipments can't back up.



THE INDEPENDENT INCANDESCENT LAMP CO. - CLEVELAND, OHIO - FACTORY, 78-84 SENECA ST. OFFICE ROSE BUILDING

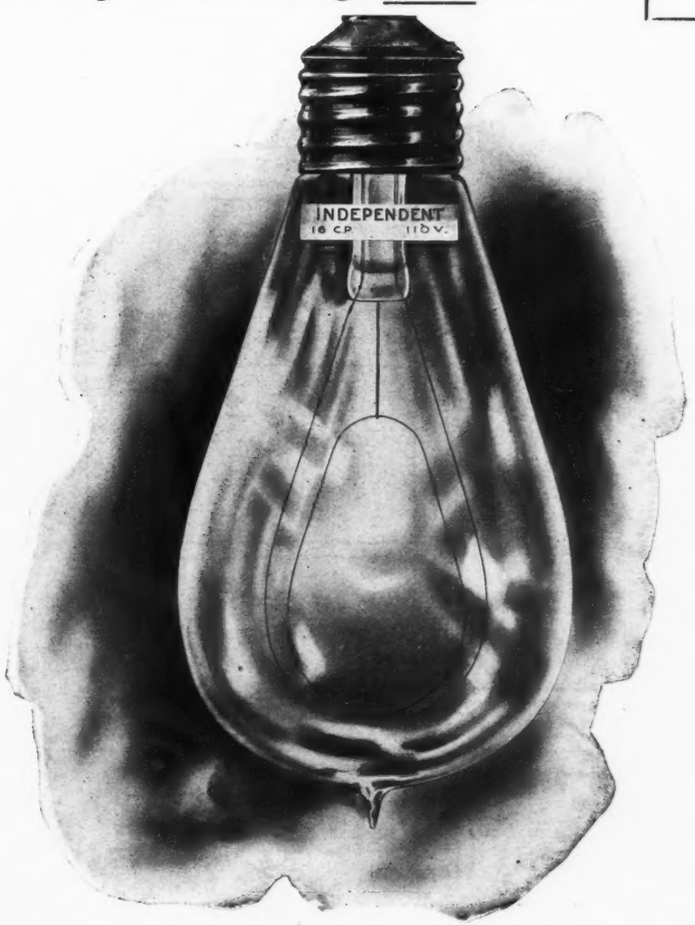
Our Quality Will Attract You

We have made certain of that by one year of constant unremitting labor before we asked for your patronage. We think we have spent more money in improving our quality than any of the older factories. We had to—they don't, or think they don't.

Carry us in mind when you want anything in lamps. High-volt, low-volt, high-candle, low-candle, round, colored, bunghole or candelabra lamps; it's all one to us—quick shipment, from large tested stock.

The Chip on his Shoulder.

Independent—
And we are.



THE INDEPENDENT INCANDESCENT LAMP CO. - CLEVELAND, OHIO -

FACTORY, 78-84 SENECA ST.
OFFICE, ROSE BUILDING

PLATINUM

PLATINUM FOR CONTACT POINTS IN ELECTRICAL INSTRUMENTS.
PLATINUM FOR TELEPHONES. PLATINUM FOR ELECTRICAL INSTRUMENTS.

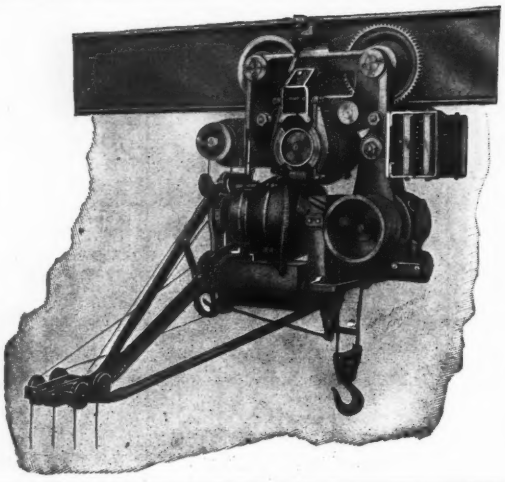
We sell PLATINUM in any quantity, either large or small. We buy PLATINUM, or anything containing PLATINUM, in any quantity.

FOR INCANDESCENT LAMPS AND EVERYTHING ELSE.

BAKER & CO.

MANUFACTURERS OF PLATINUM IN ALL SHAPES.

Newark, N. J. New York Office, 120 Liberty St.



Sprague Hoists

ARE IN GREAT DEMAND

They are in operation in many of the largest manufacturing plants in this country, and are economizing labor and increasing outputs to a wonderful extent. They are designed to handle loads up to four tons.

Write for particulars.

SPRAGUE ELECTRIC COMPANY

General Offices, 527-531 West 34th St., NEW YORK

Sterling Extra Insulating Varnish

STERLING EXTRA BLACK FINISHING VARNISH
STERLING BLACK AIR DRYING VARNISH
STERLING BLACK CORE PLATE VARNISH

The Sterling Varnish Co.
PITTSBURGH, PA., U. S. A.

The Sterling Varnish Co.
BRAUGHTON ST., BLACKFRIARS ROAD, SALFORD, MANCHESTER, ENGLAND

GET ALLEN Soldering (a flux) Sticks

INSTEAD OF RESIN, ACIDS, SOLDERING SALTS

Large Sample Free
MADE BY
L. B. ALLEN CO., Inc., 1335 Columbia Avenue, Chicago

WESTON Standard, Portable, Direct-Reading

Voltmeters, Ammeters
Millivoltmeters, Voltameters
Milammeters, Ohmmeters
Portable Galvanometers
Ground Detectors and
Circuit Testers

Our Portable Instruments are recognized as THE STANDARD the world over. Our STATION VOLTMETERS AND AMMETERS are unsurpassed in point of extreme accuracy and lowest consumption of energy.

WESTON ELECTRICAL INSTRUMENT CO.

New York Office, 74 Cortlandt Street. WAVERLY PARK, NEWARK, N. J.

BERLIN—European Weston Electrical Instrument Co., Ritterstrasse No. 88.
LONDON—Elliott Bros., Century Works, Lewisham.
PARIS, FRANCE—E. H. Cadiot, 12 Rue St. Georges. 1

INDIA MICA

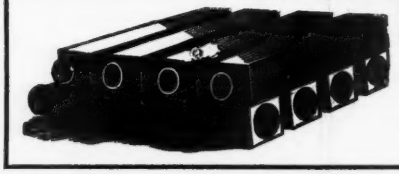
We Import Directly from India and Handle the Output of the Best Mines. A Large Stock Constantly on Hand Enables Us to Make Prompt Shipments ALL OTHER QUALITIES. Prices Low.

EUGENE MUNSELL & CO.
CHICAGO NEW YORK 2

SEE PAGE 84

AMERICAN STORAGE CELLS ARE THE BEST

SEND FOR DESCRIPTIVE CIRCULAR
AMERICAN BATTERY CO.
173 S. CLINTON ST., CHICAGO, ILL.
ESTABLISHED 1899



THE WYCKOFF PIPE & CREOSOTING CO. : : :

MANUFACTURERS OF
Wyckoff Wooden Conduits,
CROSS-ARMS AND LUMBER.
Works at PORTSMOUTH, VA.
Office, - - STAMFORD, CONN.

WHEN ADDRESSING ADVERTISERS PLEASE MENTION THIS PAPER.

SPC Armature and Field Coil Varnish

PEACOCK BRAND SPC TRADE MARK REGISTERED

"STANDARD" for 15 Years

Absolutely water and acid-proof. Resists great heat. Does not chip or peel. We refer to every corporation which has used it.

The STANDARD PAINT COMPANY
Address Dep't E 100 William St., N. Y.

EDISON MINIATURE LAMPS

are made in more than
10,000 VARIETIES

for all classes of work in Candelabra and Decorative Lighting, Multiple and Series Burning and in all types of Battery Lamps.

Miniature Sockets and Receptacles.

EDISON DECORATIVE & MINIATURE LAMP DEPT.,
General Electric Company
Harrison, N. J

5

List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S Duvall. solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED MAY 5, 1903.

727,331 Receiver for electromagnetic waves; Reginald A. Fessenden, Pittsburg, Pa.

727,360-361 Electrical water heater; Harry M. Hill, St. Louis, Mo.

727,411 Alternating-current motor; Fred. P. McBerty, Warren, Ohio.

727,429 Electric stop motion for knitting machines; Arthur L. Patterson, Albemarle, N. C.

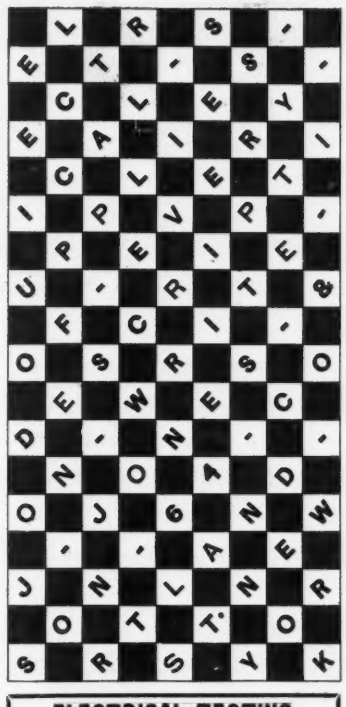
727,457 Apparatus for the continuous practice of electrolytic processes; Pedro J. Salom, Philadelphia, Pa.

727,468 Electric curling iron; Murray Shepherd, Salt Lake City, Utah.

727,471 Combined electrolytic and mechanical interrupter; Horace R. Smith, Altoona, Pa.—A combined electrolytic and mechanical interrupter, capable of acting as a condenser and a mechanical interrupter, said interrupters having independent periods of interruption, and being normally connected together in series, and means controllable at will for connecting said interrupters in parallel.

727,478 Electric switch; John L. Steeb, Butler, Pa.

(Continued on page 84.)



ELECTRICAL TESTING

We are now prepared to undertake Electrical Testing of all kinds. Electrical and Photometrical Standardizations, Tests of Lamps, Instruments, Materials and Supplies. Secondary Standards of Candle-Power furnished. LAMP TESTING BUREAU, 14 Jay St., New York. Tel. 3386 Franklin.

PATENTS

Caveats, Trade-Marks, Copyrights and Designs.

Send your business direct to Washington.
Saves time and insures better service.

PERSONAL ATTENTION
GUARANTEED.
22 YEARS' ACTIVE PRACTICE.

Specialty—
PATENTS THAT PROTECT

Address—
SIGGERS & SIGGERS
PATENT LAWYERS.
Suite 20-25
National Union Bldg. Washington, D. C.

E. S. DUVALL

GET MY CHARGES

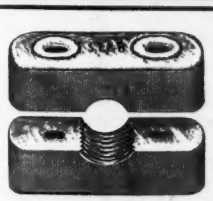
PATENTS

QUICK SERVICE

PATENTS

LOW FEES

E. S. DUVALL
LOAN & TRUST BLDG.
WASHINGTON, D. C.



SPECIAL PORCELAIN
For High Potential Work
STAR PORCELAIN IS THE BEST
Prices on receipt of model or sketch.
THE STAR PORCELAIN COMPANY
TRENTON, N. J

WIDE RANGE

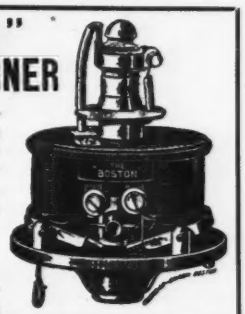
The Pittsburg Blue Print Co. write:—"*We take a great deal of pleasure in recommending Leeds No. 1 Portable Testing Set, which you shipped some time ago, to all intending users.*

"*It has a wide range and we have found it practically correct both in measurement and sensibility and in reliability of galvanometer. It is very easy to adjust and of the most superior workmanship.*"

Catalogue free on request.

JAMES G. BIDDLE
1114 Chestnut St., Philadelphia

THE "BOSTON" AUTOMATIC BURNER



The favorite of all first-class Electricians and is acknowledged by all to be the only reliable automatic in the market. Guaranteed perfect in every detail.

MANUFACTURED BY
Boston Electric Co.
29 Harrison Ave. Extension
BOSTON

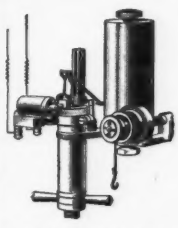
"BOSTON" AUTOMATIC. "BOSTON" MECHANISM.

CUT OUT THE BELT SLIP

USE ROPE FIBRE PULLEY COVERING

Good on any kind of pulley, wood or iron, old or new. No Preparation, special tools—put on by hand in a few minutes.

EFFECTIVE AT ONCE
ROPE FIBRE PULLEY COVERING CO.
Springfield, OHIO



THE TABOR IS THE INDICATOR

that is used for efficiency tests by the navies of the United States, Great Britain, Germany, Russia and Japan. This is pretty conclusive proof of its merits.

Our Catalogue gives description and figures

THE ASHCROFT MANUFACTURING COMPANY
85-87-89 Liberty St., NEW YORK 4

THE ELECTRICAL REVIEW

prints more general information and current electrical news items than any other paper published

H-P RUSTLESS CABLE HANGERS

COMPLETE. FIG. 1. FIG. 2. FIG. 3.

Are made of Zinc and of one piece. Besides being rustless they are durable and strong. No assembling or loss of parts, very simple and easily applied; go on the same way every time; will not jump off suspension wire nor allow cable to slip. The grip tightens with each strain on the Hanger. The hangers are 13-16 inch wide Made for all diameters.

Packed in small convenient boxes of 500 each. Ask for Sheet No. 119.

DIRECTIONS.—The circular enlargement is held in the left hand against the cable while the free end is wound once around passing through the lower slot, see Fig. 1. Around again, through the upper slot and over suspension wire, see Fig. 2. Bend free end and hook into upper slot, see Fig. 3.

JAMES S. BARRON & CO.
200-206 WEST BROADWAY, COR. FRANKLIN ST., NEW YORK

PATENTS.

(*Continued from page 83.*)

727,496 Plate for electric accumulators; Donato Tommasi, Paris, France.

727,525 Electric battery for body wear; Richard Wingren, Burlington, Kan.

727,543 Multiple signal transmitter; George E. King, Newton, Mass.

ISSUED MAY 12, 1903.

727,563 Electric switchboard and circuits; V. G. Apple, Dayton, Ohio.

727,564 Regulator for gas engines; V. G. Apple, Dayton, Ohio.

727,565 Electric governor for gas engines; V. G. Apple, Dayton, Ohio.

727,566 Igniting system; V. G. Apple, Dayton, Ohio.

727,567 Electric switch; V. G. Apple.

727,568 Dynamo electric machine; V. G. Apple

727,569 Shunt wound series arc lamp; M. H. Baker, E. Liberty, Pa.—In an electric lamp, an upper carbon carrier, means normally tending to raise the same and strike the arc, means for restraining said arc striking means, and means for removing the restraining means when the lamp is operated.

727,570 Means for separating air from liquid in carbonating or other apparatus; C. L. Bastian, Chicago, Ill.

727,571 Brush-holder; A. F. Batchelder, Schenectady, N. Y.—Attaching means comprising a plate having a bolt-hole and a sleeve integral with said plate and located with its axis oblique to the axis of the bolt-hole.

727,573 Electromagnetic clutch; E. V. Beals, Boston, Mass.

727 578 Electric time-switch; W.C. Blundell, Kansas City, Mo.

727,590 Lamp socket; W. H. Cole, Watertown, Mass.

727,596 Electric arc-lamp; A. G. Davis, Schenectady, N. Y.—A monocyclic square, electrodes of an arc-lamp in the bridge circuit of said monocyclic square, and an arc controlling means in circuit with a side or sides of said square.

727,601 Synchronizing apparatus for alternators; F. T. Dow, Schenectady, N. Y.

727,605 Anti-hunting device for dynamo-electric machines; H.F.Erben, Schenectady, N. Y.

727,606 Meter; W. C. Fish, Lynn, Mass.—An electric meter having a frame and a shaft journaled therein and a current-carrying coil, and electromagnetic means for relieving the pressure between the shaft and the frame energized by the current passing through the potential-coil.

727,608 Contact device for trolleys; C. L. Fitch, Grand Rapids, Mich.

727,611 Apparatus for maintaining uniform resistance in electric circuits; F. A. Gilbert, Brookline, Mass.

727,624 Time-limit circuit-controller; C. D. Haskins, Schenectady, N.Y.

727,625 Periodic circuit-closer; C. D. Haskins, Schenectady, N. Y.

727,633 Electric base-ball register; J. M. Humphreys, Trenton, N. J.

727,634 Telephone; M. R. Hutchinson, New York, N. Y.

(*Continued on page 86.*)

For Sale—RAILS—Wanted for Cash.

Generators, Motors, Cars, Engines, Boilers —$300,000 worth listed in JOHNSON'S EQUIPMENT BULLETIN Write for copy No. 13

Charles F. Johnson, 908 Ellicott Square, Buffalo, N. Y.

Low Cost Belting

We make the cheapest priced belting in the world, if wearing results are considered. "Royal Worcester" Belts save loss of time, loss of power, loss of labor; weigh the most—greatest power transmitters. Do not sag, slip, or cause accident. Most inexpensive belts to use in the world.

We shall be glad to quote you prices, or send you a sample belt for free trial in your own factory.

Let us hear from you at once.

GRATON & KNIGHT MFG. CO.
Oak Leather Belt Makers, Worcester, Mass. (1)

ELECTRIC CONDENSERS
WM. MARSHALL, Manufacturer
Standards a Specialty
709 Lexington Ave., New York

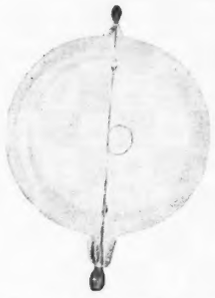
Buy the Standard
BROOKFIELD SCREW-GLASS INSULATORS
We are especially equipped for HIGH POTENTIAL POWER TRANSMISSION WORK
The Brookfield Glass Company
218-220 Broadway, New York
WORKS: BROOKLYN BOROUGH

ELECTRIC HEATING APPARATUS
OF EVERY DESCRIPTION
"Unit" Enamel Rheostats
The Simplex Electric Heating Co.
CAMBRIDGEPORT MASS.

TRANSFORMERS
For light and power service. Any voltage. Any size.

A special transformer for multiple arc street service.

Alternating current enclosed arcs, operated in multiple, is the most satisfactory street system in use to-day. :: :: :: ::
VINDEX ELECTRIC CO.
Factory, Aurora, Ill. CHICAGO, ILL.



The Lamp Shown in Cut is very useful for special decorative work. It can be wired up in series very easily and will burn 8 in series on regular 100 to 120-volt circuits. Can be supplied in colors or frosted as well as clear. Send for Catalogue showing other Novelties in Miniature and Candelabra lamps.

The Rooney-Westbury Electric Lamp Company
154 E. 23d Street, NEW YORK CITY
4

WHAT IS SCHAPIROGRAPH?

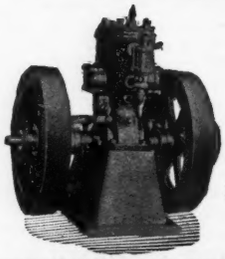
The Duplicator that cleanly multi-copies anything written with pen and typewriter, also music, drawings, etc. One original gives 150 copies Black ink in 15 minutes. Avoid: stencil, washing, delays, and expensive supplies. Price, complete cap-size outfit, $8.00. Lasts 5 years.
Sent on 5 days' free trial without deposit.
The T. T. Schapiro-Graph Co., 265 Broadway, New York

The PACKING that Packs
Have You an INDICATOR?
Do You Need a SEPARATOR
J. L. Robertson & Sons, New York

CASE BROTHERS
MANUFACTURERS OF
INSULATING AND FULLER BOARDS
All Grades and Thicknesses
Heavy Special Boards to Order
Orders promptly filled from large stock on hand
Correspondence solicited
Highland Park, Conn.

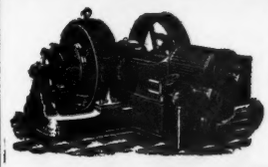
SAMSON SPOT CORD

ARC LIGHT & TROLLEY CORD
Send for Samples SAMSON CORDAGE WORKS BOSTON MASS.



GASOLENE ENGINES
FOR ISOLATED LIGHTING AND POWER PLANTS
STATIONARY, MARINE and AUTOMOBILE MOTORS
Send for Circular
THE LOWELL MODEL CO.
Drawer 1213 LOWELL, MASS.

AMERICAN-BALL DUPLEX COMPOUND ENGINE AND DIRECT-CONNECTED GENERATOR

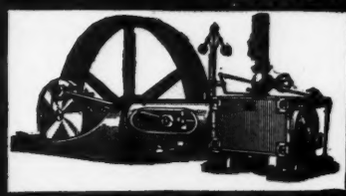


The most economical plant for generating electric currents, and the most compact plant that has yet been produced.

AMERICAN ENGINE CO.
48 Raritan Ave., Bound Brook, N. J.
New York Office: 95 Liberty St.

TRADE PAPER AD. AGENCY N. Y.

ALLIS-CHALMERS CO.,
GENERAL OFFICES CHICAGO, HOME INS. BLDG.



Reynolds Corliss Engines.

PUMPING, BLOWING AND HOISTING ENGINES.
RIEDLER PUMPS AND COMPRESSORS.
SPECIAL ENGINES FOR STREET RAILWAYS AND ELECTRIC LIGHTING.

STEAM AND ELECTRICAL EQUIPMENT

2,000-light Slattery Fort Wayne, with exciter, 133 cycles.
3— 30-kw. Westinghouse alternators, with exciter, 133 cycles.
2— 37½-kw. Westinghouse alternators, with exciter, 133 cycles.
1— 33¾-kw. Wood alternator, with exciter, 133 cycles, 2,000-volt
3— 30-kw. Edison bipolar, 110-volt, 1,200 r. p. m.
1—600-light Mather, 115-volt, 900 r. p. m.
3—400-light Edison direct-connected generators, to A. & S. engine, 80-volt.
1—250-light Quaker City, 110-volt, bipolar.
1—250-light United States, 110-volt, bipolar.
2—25-kw. United States generators, 110-volt, bipolar.
1—75-kw. Mather generator, four (4) pole, 500-volt.
1—75-kw. Short generator, 500-volt.
1—75-kw. United States generator, 500-volt.
1—30-kw. Edison generator, bipolar, 250-volt.
1— 7½-hp. Bilberg, 500-volt.
1— 1-hp. Bernard, 500-volt.
1—75-light Westinghouse arc dynamo.
1—50-light Easton arc dynamo.
4—50-light Wood arc dynamos.
20—30 and 40-light arc dynamos.

BOILERS

In great variety. All styles and types. Sixty (60) large steam pumps, up to 12" suction, assorted sizes. Iron and wood working machinery, gas and gasoline engines, etc. Send for special catalogue of 2,000 pieces.

FRANK TOOMEY, 131 N. Third St., Philadelphia, Pa.

The Ball & Wood High-Speed Engine

is noted for its smooth and silent running and its extremely low cost of maintenance. It is recognized as the standard engine for electric light and railway plants. BALL & WOOD engines are made in all types for all services requiring the best economy and efficiency

THE BALL & WOOD CO.
Works: ELIZABETHPORT, N. J.
120 Liberty St., New York City

AUTOMATIC ELECTRIC TIME SWITCHES

Let us send you descriptive matter

EUGENE B. ABBOTT, CLEVELAND, OHIO

STEEL OUTLET AND JUNCTION BOXES
Switchboards, Panel Boards, Switches, Etc.
..MADE BY..
THE BOSSERT ELECTRIC CONSTRUCTION CO.
UTICA, N. Y.

Proposals will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D C., until 12 o'clock noon, May 19, 1903, and publicly opened immediat-ly thereafter, to furnish at the Navy Yards, Portsmouth, N. H.; Boston, Mass.; New York; League Island, Pa; Norfolk, Va., and Pensacola, Fla., a quantity of **electrical material, blocks, bolts, nuts, rivets, brushes, brooms, cement, stone, canvas, dry goods, silver plated ware, crockery, glassware, filters, glass, hardware, locks, hinges, tools, crocus and emery cloth, drawing instruments, thermometers, musical instruments, lamps and lamp fixtures, leather and belting, lumber, timber, railroad ties, drills, taps, dies, brass, copper, zinc, lead, iron, steel, rails, solder, packing, hose, pipe covering, asbestos, alcohol, shellac, lye, polishing paste, pipe, pipe fittings, gauge glasses, valves, thimbles, grommets, cork jackets, stat onery, bake ovens, sponges, beeswax, waste, soap and platform cars.** Blank proposals will be furnished upon application to the navy pay offices, New York; Portsmouth, N. H.; Boston, Mass.; Philadelphia, Pa.; Norfolk, Va., and Pensacola, Fla. A. S. KENNY, *Paymaster General U. S. N.* 4-27-03.

NOW IS THE TIME

TO SUBSCRIBE FOR
The Inventive Age & Patent Index
ONE DOLLAR A YEAR

Replete with matter pertaining to Patent Office and New Inventions

Contains index of all patents issued

ADDRESS
INVENTIVE AGE PUBLISHING CO.
918 F St., Washington, D. C.

SIGN FLASHERS
Signs and Decorations
WRITE FOR BULLETINS
The Electric Motor & Equipment Co.
NEWARK, N. J.

NEW PROCESS NOISELESS RAWHIDE PINIONS

MAKE AN IDEAL DRIVE

When running into accurately cut metal gears they transmit power positively and with minimum noise and vibration. Send for Catalogue.

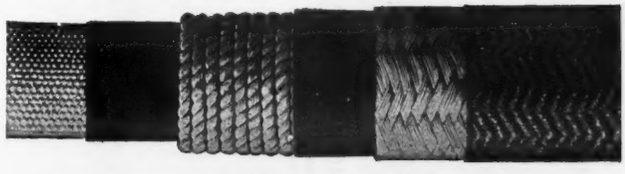
WE ALSO MAKE AND CUT METAL GEARS

THE NEW PROCESS RAW HIDE CO.
SYRACUSE, N. Y.

WHEN ADDRESSING ADVERTISERS PLEASE MENTION THIS PAPER

ALPHADUCT

FIRE-PROOF FLEXIBLE CONDUIT



CONSTRUCTION

1—Inner lining of heavy fire-proofed canvas. 2—Coating of weather-proofing. 3—Fire-proofed cord. 4—Filling of weather-proofing compound. 5—Outer jacket fire-proofed. 6—Outer coating protecting against weather and abrasion.

ALPHADUCT M'F'G COMPANY
522-524 W. 22d Street - - - NEW YORK
CHICAGO OFFICE, FISHER BUILDING, W. M. Porter, Mgr.

PATENTS.

(Continued from page 84.)

727,640 Electric meter; E. J. King, Fort Wayne, Ind.—A phase-adjusting winding or coil, means for impressing an electromotive force upon said winding or coil, and a reversing switch in the leads extending to said winding or coil.

727,641 Magnetic clutch; E. Knowlton, Schenectady, N. Y.

727,662 Induction motor for variable speeds; A. Meuschel, Montreal, Canada.

727,684 Electric-motor system; W. B. Potter, Schenectady, N. Y.

727,685 Cooling dynamo-electric machines; E. D. Priest, Schenectady, N. Y.

727,686 Means for cooling dynamo-electric machines; E. D. Priest.

727,687 Lightning arrester; H. E. Raymond, Schenectady, N. Y.—A lightning arrester provided with cup-shaped discharges, having small mass and large surface area, and arranged one within another with their openings facing the same direction.

727,688 Lightning arrester; H. E. Raymond, Schenectady, N. Y.

727,689 Magnetic clutch; H. G. Reist, Schenectady, N. Y.

727,690 Electric-arc lamp.

727,701 Telephone system; C. B. Smith, New York, N. Y.

727,702-704 Electrical signaling or calling system; C. B. Smith, New York, N. Y.

727,713 Means for accentuating electrical contacts; E. Thomson, Swampscott, Mass.

727,714 Electric arc-lamp; E. Thomson, Swampscott, Mass.

727,756 Device for reinsulating electric and aerial telephone or other cables; J. Daggett, Elyria, Ohio.

727,763 Electrical switchboard; E B. Ellicott, Chicago, Ill.

727,764 Electrical protective device; E. B. Ellicott, Chicago, Ill.

727,801 Telephone call-annunciator; G. K. Jackson, Reece, Kan.

727,828 Electric time-switch; M. A. Nickerson, Canton, N. Y.

727,842 Ceiling or wall box; J. T. Robb, Brooklyn, N. Y.

727,848 Apparatus for boiling by electricity; R. C. Sayer, Bristol, England.

727,865 Ground detector for electric circuits; T. W. Varley, New York.

727,870 Intermittent automatic switch; H. Wolf, Jr., Cincinnati, Ohio.

727,880 Telephone special directory; L. M. Bannan, San Francisco, Cal.

727,889 Electrolytic apparatus; F. J. Briggs, Everett, Mass.

727,996 Electric push-button; J. Y. Parke, Philadelphia, Pa.

728,015 Insulating joint; J. T. Robb, Brooklyn, N. Y.

728,023 Method of electric welding; J. Schurek, Milwaukee, Wis.

728,034 Regulator for electric currents; T. Spencer, Philadelphia, Pa.

728,038 Alternating-current electric motor; B. Stowe, Cleveland, Ohio.

728,039 Electric motor; B. A. Stowe, Cleveland, Ohio.

728,060 Switchboard incandescent lamp; A. D. Whipple, Chicago, Ill.

728,076 Galvanometer; A. Blondel, Paris, France.

728,092 Connector for electrical batteries; W. R. Edwards, Weybridge, England.

728,119 Automatic electric chain-welding machine; C. A. Luenberger, Biel, Switzerland.

728,147 Telephone selecting device; W. D. Watkins, San Jose, Cal.

728,152 Insulating means for electrical apparatus; A. F. Batchelder, Schenectady, N. Y.

728 161 Combined telephone and fire-alarm system; W. L. Denio, Rochester, N. Y.

728,162 Telephone; W. L. Denio, Rochester, N. Y.

728,164 Signal-controlling system for electric railways; G. Gibbs, New York, N. Y.

728,165 Signaling apparatus for telephone lines; F. E. Green, Newburyport, Mass.

728,183 Process of winding electrical coils; R. Varley, Providence, R. I.

WANTED

Three experienced incandescent lamp salesmen, by an old and well established Company not in the Trust. Applicants will please state age, experience and salary wanted.

"INDEPENDENT"
Care ELECTRICAL REVIEW, NEW YORK

WANTED

One experienced incandescent lamp salesman at once

THE SHELBY ELECTRIC CO.
Shelby :: :: :: Ohio

EXCELLENT OPPORTUNITY

$15,000.00 will secure a controlling interest in a well established and profitable electrical contracting, inspection and repair business, located in New York City. Complete machinery and equipment. Owner retiring from business. Thorough investigation to principals only. Address "GOOD CHANCE"
Care Electrical Review, Box 339, New York

FOR SALE

One (1) "Wood" single-phase alternating-current generator in first-class condition, practically as good as new, 1,000 volts, 371⅓ amperes, 1,400 R. P. M., with exciter, marble switchboard and instruments complete, available for immediate shipment.

NASSAU LIGHT & POWER COMPANY
ROSLYN, L. I.

THE SCHWERDTLE STAMP CO.,
STENCILS-BURNING BRANDS
STEEL STAMPS & DIES
SEALS-MACH. PLATES-CHECKS
BRIDGEPORT, CONN.

DETROIT AND BUFFALO STEAMBOAT Co.

QUEENS OF THE LAKES
Steamers Eastern States and Western States

$3 SAVED
TO ANY POINT WEST

Lv. BUFFALO daily 5.30 P. M., ar. DETROIT 7.30 A. M., connecting with all trains West and D. & C. for Michigan resorts Lv. DETROIT daily 4.00 P. M, ar. BUFFALO 7.30 A. M. Fare: $3.50 one way, round trip $6.50. Berths $1.00 and $1.50, rooms $2.50, parlors $5.00, each way. Week End Excursions DETROIT and Return, $3.00. Send 2c. for illustrated pamphlet.
Address A. A. SCHANTZ, G. P. T. M., Detroit, Mich.

DEALERS WRITE FOR DISCOUNT.
LINEMEN SEND $1.50 FOR A PAIR OF MY 3 RIVETS CLIMBERS
J. DONNELLY. PATENT PENDING.
U CAN RE-SPUR THESE. I WILL MAIL 2 SPURS, POST PAID, FOR 40 CTS.
SOLE MAKER JOHN DONNELLY
BOX 379, BRANFORD, CONN. U.S.A.

ATLANTIC INSULATED WIRE AND CABLE CO.
WIRES AND CABLES
FOR SUBMARINE, AERIAL, UNDERGROUND AND INTERIOR USE
FACTORY STAMFORD, CONN.
120 LIBERTY STREET NEW YORK CITY

BARGAIN IN FEED WATER HEATERS.

One Goubert horizontal 800 H. P. feed water heater, flanged for 14-inch pipe connections.
One Goubert vertical 800 H.P. feed water heater, with cast-iron supports complete, flanged for 16-inch pipe connections.

These heaters are new, having been received recently from the factory and never having been used. They are for sale on account of the plant in which they were to be used having been changed in arrangement, necessitating the use of heaters of a different style. Price will be made an object and quoted on application.

MICHIGAN ELECTRIC COMPANY,
DETROIT, MICH.

"Foreman of Machine Shop wanted to take charge of operating one department of a Rock Crushing Plant in New Jersey. Must have had considerable experience in general machine work and full charge of at least twenty-five (25) men. Give names of shops in which you have worked and length of time in each place. Also full personal references. Replies without full details will not be noticed. Wages Six Dollars ($6.00) per day. Address "Cement,"
Care ELECTRICAL REVIEW, New York

WANTED

A thoroughly experienced man as superintendent of a rubber insulating wire plant. Address

"X. A. M."
Room 809, 11 William Street, New York.

WANTED

SALESMEN FOR INCANDESCENT LAMPS.

State age, height and weight, whether married or not, electrical experience, whether college graduate, what degree, and territory familiar with. Address

"INCANDESCENT"
Care ELECTRICAL REVIEW New York

COAL AND ASHES
HANDLING MACHINERY
We have manufactured this kind of machinery for thirty years.
C. W. HUNT COMPANY
WEST NEW BRIGHTON, N. Y.
See our adv. opposite page next week.

SENT UPON APPLICATION

SENT UPON APPLICATION

HYLO

The only turn-down lamp anybody ever bought again

THE PHELPS COMPANY
29 Rowland St., Detroit, Mich.

BUSINESS MANAGER WANTED

Capable of directing large enterprise (plant in New Jersey nearing completion). Must possess marked executive ability, sound judgment, tact, energy and aptitude for details; must have a successful record as manager in some manufacturing line where he has organized and controlled advantageously the various departments. Manager will have full charge subject to executive officers. Highest references required; very liberal salary to start and chance to increase to one showing results. State age. Address

PORTLAND CEMENT,
ORANGE, NEW JERSEY

FLEMING SLATE CO.

MILL & QUARRIES, POULTNEY, VT.

Purple and green slate for ELECTRICAL, Billiards, Structural PLUMBING and ROOFING MARBLEIZING.

The 1903 Copper Handbook

The World's Standard Reference Book On Copper

The 1903 International Edition is new from cover to cover. It lists and describes 2,207 copper mines and copper mining companies, in all parts of the world. It has greatly amplified chapters on the History, Geology, Chemistry, Mineralogy, Metallurgy, Uses and Statistics of Copper; eight chapters devoted to the various Copper Mining Fields of the World; a long chapter of Statistical Tables, and descriptions ranging from a few lines to eleven pages, of the world's Copper Mines.

The 1903 edition is the result of nearly ten years' labor. It is made for the investor, miner, smelter, scientist or any other person interested in the subject of copper from any standpoint. The book has 600 octavo pages, with gilt tops. Price, $5 in buckram or $7.50 in full library morocco.

It Will Be Sent on Approval, Fully Prepaid

to any address in the world, on the understanding that the person ordering may return it within a week of receipt, and charge will be cancelled if the book is unsatisfactory, for any reason whatsoever, or for no reason at all. It costs nothing to see the Copper Handbook, and it need not be kept unless it suits. May we send you a copy on these terms?

Address all orders to the Author and Publisher,

Horace J. Stevens,
45 Post Office Block,
HOUGHTON, MICH.

PLATINUM

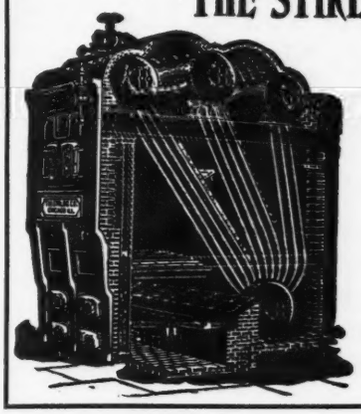
SHEET AND WIRE for all purposes and all shapes in any quantity
Special rates for Refining and Reworking Platinum or anything that contains Platinum
Highest Prices Paid for Scrap Platinum
CROSELMIRE & ACKOR
Manufacturers and Importers of Platinum of all kinds
Factory and Main Office, NEWARK, N. J., 42 Walnut St. N. Y. OFFICE, 10 East 23d St., Room 5

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
HARTFORD, CONN.

Ten Days FREE TRIAL
allowed on every bicycle bought of us before purchase is binding.
We ship C. O. D. on approval to anyone without a cent deposit.
New 1903 Models
"Ballise," complete $8.75
"Cossack," Guarantee. $10.75
"Siberian," High Grade a beauty. $12.75
"Howdorf," Road Racer $14.75
no better bicycles at any price.
Any other make or model you want at one-third usual prices. Choice of any standard tires and best equipment on all our bicycles. Strongest guarantee.
RIDER AGENTS WANTED in every town to help example wheel at special price and take orders for our improved '03 models. There's big money in it.
500 Good 2nd-hand Wheels $3 to $8.
DO NOT BUY a bicycle until you have written for our free catalog with large photographic engravings and full descriptions.
MEAD CYCLE CO. Dept. 224-C Chicago.

WHEN ADDRESSING ADVERTISERS PLEASE MENTION THIS PAPER.

THE STIRLING WATER-TUBE SAFETY BOILER.



Safe.
Efficient.
Durable.
Over 1,000,000 Horse-Power in use.
All wrought metal; no flat surfaces or stay bolts; four manholes give access to every tube. Quick and steady steam and thorough circulation guaranteed.
THE STIRLING COMPANY
Pullman Bldg., Chicago, Ill.
New York Office, 114-118 Liberty St.
Philadelphia Office, Betz Bldg.
Boston Office, Delta Bldg.

COLUMBIA ARC LAMPS
ECONOMICAL
SIMPLE, DURABLE
COLUMBIA ELECTRIC & MFG. CO.
Office & Factory, 316-322 Market St.
NEWARK, N. J.

RISING SUN
Carbon Papers and Typewriter Ribbons.
NON-SMUT NON-GREASE
Send for Samples
E. F. P. RAPPEL
140 Nassau St., New York

LITTLE JOURNEYS to lake resorts and mountain homes will be more popular this summer than ever. Many have already arranged their summer tours via the

Chicago, Milwaukee & St. Paul Railway

and many more are going to do likewise. Booklets that will help you to plan your vacation trip have just been published, and will be sent on receipt of postage, as follows:

"Colorado-California," six cents.
"In Lakeland" and "Summer Homes," six cents.
"Lakes Okoboji and Spirit Lake," four cents.

F. A. MILLER,
General Passenger Agent,
CHICAGO.

THE BABCOCK & WILCOX CO.
85 LIBERTY ST. NEW YORK
CABLE ADDRESS "GLOVEBOXES" ALL FOREIGN OFFICES "BABCOCK"
STEAM
WATER TUBE BOILERS
SEND FOR OUR BOOK "STEAM"
BOSTON
PHILADELPHIA
SAN FRANCISCO
CHICAGO
ATLANTA, GA.
MEXICO, CITY.
HAVANA, CUBA

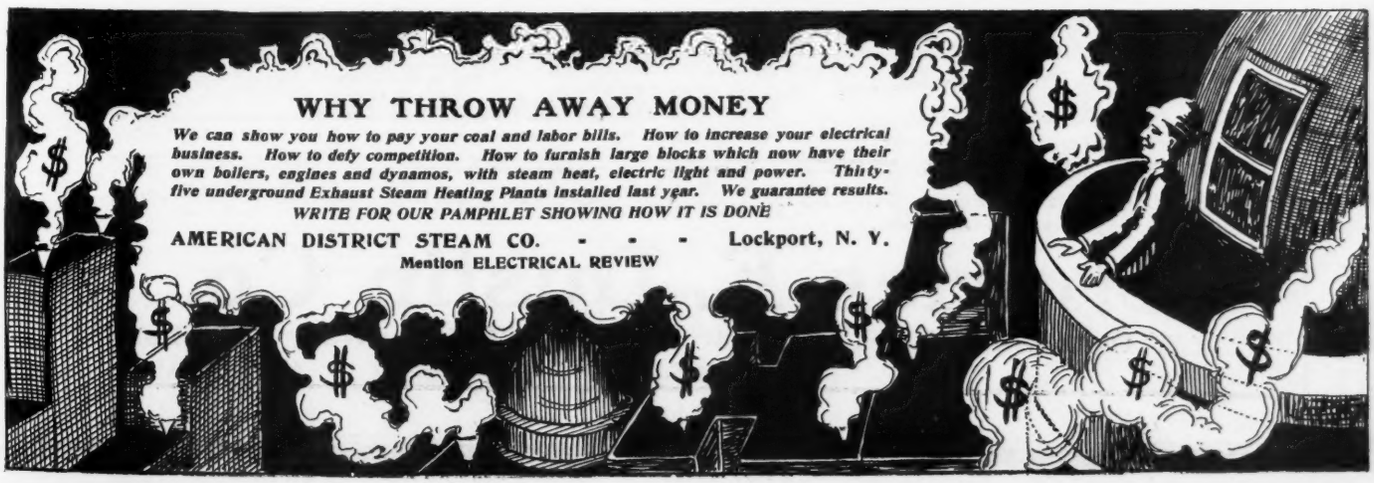
ELECTRICAL ENGINEERING TAUGHT BY MAIL

Write for our free illustrated book "CAN I BECOME AN ELECTRICAL ENGINEER?"
We teach Electrical Engineering Electric Lighting, Electric Railways, etc., at your home by mail. Institute indorsed by Thos. A. Edison.
ELECTRICAL ENGINEER INSTITUTE
Dept. M, 240-242 West 23d St., New York.

JEFFREY
Elevating—Conveying—Power Transmission
Screening—Crushing Coal Mining—Coal and Rock Drilling—Coal Washing Machinery and Electric Locomotives. Catalogues are yours for the asking. Address
THE JEFFREY MFG. CO.
COLUMBUS, OHIO, U. S. A.

THE BRADY MAST ARMS
T. H. BRADY, New Britain, Conn., U. S. A.
MANUFACTURER OF
Mast Arms, Pole and Swinging Hoods, House Brackets and other specialties for construction work
Catalogue and Prices Furnished on Application

CARBONS and lamp filaments baked with Dixon's No. 1365 Graphite do not lose their carbon. Furnished in any degree of fineness. Ask for booklet 48.
JOSEPH DIXON CRUCIBLE CO., JERSEY CITY, N. J.



WHY THROW AWAY MONEY
We can show you how to pay your coal and labor bills. How to increase your electrical business. How to defy competition. How to furnish large blocks which now have their own boilers, engines and dynamos, with steam heat, electric light and power. Thirty-five underground Exhaust Steam Heating Plants installed last year. We guarantee results.
WRITE FOR OUR PAMPHLET SHOWING HOW IT IS DONE
AMERICAN DISTRICT STEAM CO. - - - Lockport, N. Y.
Mention ELECTRICAL REVIEW

APPARATUS

For POWER-HOUSE, CENTRAL STATION and FACTORY EQUIPMENT

A Two Phase Stanley Alternating Direct Connected Unit

CONSISTING OF One 300 kw. Stanley, 60 cycle, two phase, 2,400 volt alternator with phase regulation directly connected to a 16-32 x 24 McIntosh, Seymour & Co. Vertical Cross Compound Engine. Speed 165 R. P. M.

Alternators

One 250 kw., General Electric, 2,400 volts, 50 cycles, three phase, speed 600 R. P. M.
One 200 kw., General Electric, 2,300 volts, 40 cycles, three phase speed 480 R. P. M.
One 180 kw., General Electric, 2,300 volts, 60 cycles, single phase, speed 600 R. P. M.
One 180 kw., Westinghouse, 2,300 volts, 60 cycles, two phase, speed 514 R. P. M.
One 150 kw., Westinghouse, 2,300 volts, 60 cycles, single phase, speed 625 R. P. M.
One 150 kw., Stanley, 1,100-2,200 volts, 133 cycles, two phase, speed 800 R. P. M.
Two 120 kw., General Electric, 1,040 volts, 125 cycles, single phase, speed 1,070 R. P. M.
One 120 kw., General Electric, 2,080 volts, 125 cycles, single phase, speed 1,070 R. P. M.
One 90 kw., General Electric, 2,300 volts, 60 cycles, single phase, speed 900 R. P. M.
One 75 kw., Stanley, 1,200-2,400 volts, 133 cycles, two phase, speed 1,000 R. P. M.
One 60 kw., Westinghouse, 2,200 volts, 60 cycles, two phase, speed 900 R. P. M.
Three 35 kw., Thomson-Houston, 1,100 volts, 125 cycles, single phase, speed 1,500 R. P. M.
One 60 kw., Westinghouse, 2,200 volts, 60 cycles, single phase.
One 45 kw., Westinghouse, 2,200 volts, 60 cycles, single phase.

Street-Railway Generators

Two 500 kw., G. E., 6-pole, speed 300 R P. M.
Two 300 kw., G. E., 4-pole, speed 400 R. P. M.
One 225 kw., G. E., 6-pole, speed 465 R. P. M.
One 200 kw., Westinghouse, 6-pole, speed 510 R. P. M.
Two 200 kw., G. E., 4-pole, speed 425 R. P. M.
Two 180 kw. Westinghouse, 4-pole. speed 535 R. P. M.
One 110 kw., Eddy, 4-pole, speed 600 R. P. M.
Two 100 kw., G. E., 4-pole, speed 650 R. P. M.
One 100 kw., Walker, 4-pole, speed 750 R. P. M.
Two 100 kw., Edison, bipolar, speed 620 R. P. M.
One 90 kw., T.-H., 4-pole. speed 700 R. P. M.
One 80 kw., G. E., 4-pole, speed 700 R. P. M.
Two 80 kw.. Detroit bipolar, speed 620 R. P. M.
Five 62 kw., T.-H., type D, speed 900 R. P. M.
One 50 kw., Brush, type Q, speed 1,050 R. P. M.
One 45 kw., G. E., 4-pole, speed 1,040 R. P. M.

Engines

One 26 x 48 Harris Corliss, 500 H.-P.
One 18-34 x 48 Cooper Corliss cross-compound, 500 H.-P.
One 23 x 48 Harris Corliss, 400 H.-P.
One 22 x 33 Buckeye, 400 H.-P.
One 20 x 36 Hewes & Phillips, 200 H.-P.
One 18 x 48 George H. Corliss, 250 H.-P.
One 16 x 42 Providence Greene, 200 H.-P.
One 20 x 40 Buckeye, 250 H.-P.
Two 18-30 x 16 Westinghouse compound, 250 H.-P. each.
Three 18½ x 18 Armington & Sims, 250 H.-P. each.
One 18½ x 18 New York Safety, 250 H.-P.
Two 10-18 x 20 Payne tandem-compound, 150 H.-P. each.
One 13-19 x 15 McIntosh, Seymour & Co., tandem, 175 H.-P.
Two 14 x 13 Armington & Sims, 150 H.-P.
One 14 x 14 Rice automatic, 125 H.-P.
One 13 x 12 Armington & Sims, 125 H.-P.
One 12 x 36 Harris Corliss, 100 H.-P.
One 12-20 x 12 Westinghouse compound, 100 H.-P.
One 12x12 New York Safety, 100 H.-P.
One 12 x 12 Watertown, 100 H.-P
One 10½-16½ x 12 Armington & Sims cross-compound, 100 H.-P.
One 9 x 16 Rice Automatic, 75 H.-P.
One 10 x 30 Harris Corliss, 80 H.-P.
One 9 x 9 Taylor Beck, 50 H.-P.
One 7 x 8 Payne, 20 H.-P.
Three 6 x 5 Westinghouse Junior, 12 H.-P. each.
Two 5 x 4 Westinghouse Junior, 6 H.-P. each.

ALSO A LARGE STOCK OF DIRECT-CURRENT GENERATORS AND MOTORS, 110-220 AND 500 VOLTS

Railway Motor Equipments

Six complete G. E. 58 Equipments, each consisting of two G. E. 58 (37 H.-P.) motors with gears, pinions and gear cases; two K10 Controllers with resistances, one U. S. 6 Trolley, two Main Motor Switches, one 150 amp. Magnetic Cutout, one M. D. Lightning Arrester, and necessary car wiring cables, power wiring material and car lighting material, including ten lamps. Motors and controllers only are second hand. All other material absolutely brand new. Also G. E. 52, 800 and 1,000 Motors with K2 Controllers, Westinghouse 12 and 38B Motors with K2 Controllers.

Direct-Connected Lighting and Power Units

One 130 kw., G E., 8-pole, 125-volt generator, with 12-20 x 16 Erie Ball tandem-compound engine.
One 60 kw.. Eddy, 4-pole, 125-volt generator, with 13 x 12 Buffalo Forge engine; brand new.
One 50 kw., Commercial, 6 pole, 125-volt generator, with 8½-13 x 12 Armington & Sims tandem-compound engine.
One 50 kw., Eddy. 4-pole, 125-volt generator, with 13 x 12 Harrisburg Ideal engine.
One 50 kw. Unit, consisting of two 25 kw., General Electric, 4-pole, 125-volt generator. with one triple-expansion vertical engine.
One 25 kw., General Electric, 6-pole, 125-volt generator, with 9½ x 10 Armington & Sims engine.
Two 25 kw., Westinghouse, 6-pole, 250-volt generators, each with 9 x 10 Ball & Wood engine.

Generators

110-125 Volts

One 100 kw., General Electric, 4-pole, compound wound, speed 650 R. P. M.
One 75 kw., Bullock. 4-pole, compound wound, speed 890 R. P. M., with voltmeter and ammeter.
One 30 kw., Hobart, 4-pole compound wound.
One 30 kw., Thomson-Houston spherical type, compound wound, speed 1,150 R. P. M.
One 25 kw., General Electric, 4-pole, compound wound, speed 650 R. P. M.
One 25 kw., Loomis, bipolar, compound wound, speed 1,150 R. P. M.
One 25 kw., Eddy, 4-pole, compound wound, speed 1,150 R. P. M.; brand new.

Arc Generators

One No. 12 Brush, 9.6 amperes, 125 lamps.
Two No. 12 Brush, 6.6 amperes, 170 lamps.
Two No. 11 Brush, 9.6 amperes, 120 lamps.
Four No. 9 Brush, 9.6 amperes, 80 lamps.
Two No. 9½ Brush, 6.6 amperes, 120 lamps.
One No. 9B Brush, 6.6 amperes, 120 lamps.
Five M. D. 12 T.-H., 6.8 amperes, 75 lamps.
Two M. D. 2 T.-H., 9.6 amperes, 50 lamps.
Six L. D. 12 T.-H., 6.8 amperes, 50 lamps.
One M. 12 T.-H., 6.8 amperes, 45 lamps.

Alternating Motors

One 300 H.-P. General Electric, 2,400 volts, 50 cycles, two phase, speed 600 R. P. M.
Two 200 H.-P. Stanley synchronous motors, 133 cycles, two phase, 2,400 volts, speed 1,000 R.P.M.
One 200 H.-P. Westinghouse, type C, 25 cycles, two-phase, 400 volts, speed 480 R. P. M.
One 130 H. P. Westinghouse, type C, 60 cycles, two-phase, 200 volts, speed 850 R. P. M.
Two 30 H.-P. Westinghouse, type C, 60 cycles, two phase, 400 volts, speed 850 R. P. M.
Two 20 H.-P. Westinghouse, type C, 60 cycles, two phase, 200 volts speed 840 R. P. M.
One ½ H.-P. General Electric, 60 cycles, single phase, 110 volts, speed 1,800 R. P. M.

Babcock & Wilcox Water-Tube Boilers and many others. Arc Lamps both for direct and alternating current, series or multiple circuits. Transformers, General Electric "H," Thomson-Houston "F" and many other types for 60 and 125 cycles.

SEND FOR OUR LATEST BULLETIN. We will make you a cash proposition for any apparatus you may have for disposal.

Charles E. Dustin Co.

Factory and Storehouse **Orangeburgh, N. Y.** **11 Broadway, New York**

Machinery For Sale

Railway Generators

DIRECT-CONNECTED

1—425-kw General Electric, Type M. P.,10-425-100 R. P. M. with Compound Russell Engine.

2—300 kw General Electric, Type M. P., 6-300-100 R. P. M. with Compound Allis Engines

2—225-kw Westinghouse with Compound Vertical Westinghouse Engines. Kodak type outfits.

Direct-Connected Units

110-125 Volts

1—50-kw 6-pole Sprague, direct-connected to a 14x13 Harrisburg Standard Engine. Speed 275 R. P. M. This unit is new.

1—25-kw 6-pole General Electric, direct-connected to Vertical Compound Westinghouse Automatic Engine. Speed 350 R. P. M.

1—2½-kw 4 pole 23-amp. General Electric Dynamo, direct-connected to a 4¼"x4" Forbes Vertical Automatic Engine. Speed 700 R. P. M.

Alternating Unit Direct-Connected

1—600-kw General Electric, Type A. T. B., 80-600-90 R. P. M., direct-connected to 32x48 Allis Engine. Voltage 605. Complete with transformers.

Rotary Converters

2—250-kw Westinghouse, 2-phase, 7200 alternations and 535 volts direct current, speed 720 R. P. M.

4—150-kw oil-cooled transformers, 3-phase, 2-phase, 60-cycle, 9500 volts primary, 380 volts secondary.

All complete with one 4-panel switchboard.

Railway Motors

50—38 B Westinghouse.
20—49 Westinghouse.
50—12 A Westinghouse.
25—68 Westinghouse.
20—69 Westinghouse
10 G. E. 52.
10—G. E. 800.
50—No. 3 Westinghouse.
K, K2, K10, K11, K12, Controllers.

RAILWAY GENERATORS
Belted

2—500-kw General Electric, M. P.
2—300-kw General Electric, M. P.
4—200-kw General Electric, M. P.
1—200-kw Westinghouse, 6 pole.
2—100-kw General Electric, M. P.
1—150-kw Ft. Wayne, M. P. 6.
2—200-kw Edison.
1—60-kw Edison, Bipolar, M. P.
1—75-kw Thomson-Houston.
4—D62 Thomson-Houston.

EXTRA ARMATURES

1—200-kw 4 pole G. E.. 500 volts.
1—200-kw Edison, 500 volts.
1—150-kw Edison, 110 volts.

BELTED DYNAMOS AND MOTORS
110 Volts

1—100-kw M. P. Eddy.
1—100-kw Edison.
2—60-kw Edison.
1—45-kw Edison.
2—25-kw Edison.
1—50-kw Siemens & Halske.
1—30-kw M. P. Crocker-Wheeler.
1—17½-kw M. P. Bullock.
Small Motors, all sizes.

BELTED DYNAMOS AND MOTORS
220 Volts

1—45-kw Edison
1—20-kw Thomson-Houston.
1—35-H. P., M. P., C. & C.
1—25-H. P. Eddy.
1—20-H. P., M. P., Sprague.
1—15-H. P., M. P., General Electric.
1—10-H. P., C. & C.
1—10-H. P. Central Electric.
1—5-H. P. Lundell.
1—5-H. P. Triumph.
1—15-H. P. Lundell.

BELTED MOTORS
500 Volts

1—60-kw M. P. Eddy.
1—40-kw M. P. Eddy.
1—30-H. P., M. P., General Electric.
3—25-H. P., M. P., General Electric.
1—35-H. P., M. P. American Ball.
2—10 H. P., M. P., General Electric.
3—7½-H. P. M.P., General Electric.
5—5-H. P., M. P., General Electric.
3—2-H. P., M. P., General Electric.

ARC DYNAMOS

1—165-light, multi-circuit Brush, No. 12 6.8 amp.
1—125-light, multi-circuit Brush, 2,000 C. P. No. 12.
1—120-light, multi-circuit Brush, 1,200 C. P. No. 9.
1—80 light, multi-circuit Brush, 2,000 C. P. No. 9.
2—M. D. 12, 75-light, Thomson-Houston arc dynamos.
4—M. D. 2, 50-light, Thomson-Houston arc dynamos.
2—L. D. 12, 50-light Thomson-Houston arc dynamos.
4—M. 2. 45-light, Thomson-Houston arc dynamos.
3—No. 8, 65-light, 2,000 candle power Brush.

ALTERNATING MOTORS

1—130-H. P. Westinghouse.
2—30-H. P. General Electric.
3—5-H. P. General Electric.
2—3-H. P. General Electric.
All of the above are 2-phase, 60-cycle, 220 volts.

ALTERNATORS
Single-Phase

1—400-kw Ft. Wayne, 1100 volts, 125 cycle.
2—300-kw General Electric, 1100 volts, 125 cycle.
1—250-kw Westinghouse, 1100 volts, 125 cycle.
2—150-kw Ft. Wayne. 1040 volts, 120 cycle, 700 R. P. M.
2—A120 General Electric, single-phase 1,000 volts. 16,000 alternations.
1—120-kw Westinghouse, 2000 volts, 16,000 alternations, toothed arm.
3—70-kw T.-H., self-oiling, 120 cycle, 1050 volts.
2—60-kw General Electric, single-phase, 1100 volts, 16,000 alternations.
1—60 kw Westinghouse, single-phase, 60 cycle, 1100 volts.
2—60-kw Westinghouse. single-phase, 16,000 alternations, 1,100 volts.
1—45-kw Westinghouse, 2,200 volts, 16,000 alternations.
1—45-kw Westinghouse, 2,200 volts, 7,200 alternations.
2—A35 General Electric, single-phase, 16,000 alternations, 1050 volts.
1—30-kw Westinghouse, 1,100 volts, 16,000 alternations.

ALTERNATORS
2 and 3-Phase

1—650-kw 2 Phase Stanley, 133 cycle, 1200-2400 volts.
2—250-kw General Electric, type A. T. B., 16-250-450, 3-phase, 60-cycle, 10,000 volts.
2—325-kw 2-phase Stanley direct connected to Tandem Compound Russell Engines, condensing.
1—180 Westinghouse 2 phase generator 2200 volts 60 cycles belted to Westinghouse Compound Eugine 16&27 x16 units, brand new, never been run.
1—150-kw Monocyclic, 3-phase, 60-cycle, 2200 volts.
1—75-kw Stanley 2000-1000 volts, 2-phase, 60 cycle.
1 75-kw Westinghouse, 2-phase, 60 cycle, 2,200 volts.

BOILERS

1—250-H. P., B. & W. Boiler.
3 175-H. P., B. & W. Boilers.
2—175-H. P., Stirling Boilers.
1 72"x18" Return Tubular.

FEED WATER HEATERS

2—500-H. P. Stilwell-Bierce.
1—350-H. P. Berryman.
1—200-H. P. Berryman.

ENGINES

1—20x36x48 Tandem Compound Hamilton engine, wheel 22 ft. diameter 56 in. face, right hand.
1—18&34x48 Cross Compound Cooper Corliss.
1—20&36x42 Tandem Fitchburg.
1—15&30x36 Slater Cross Comp.—heavy duty—condensing.
1—16&28x18 Tandem Erie Ball.
1—16&26x17 Tandem McIntosh & Seymour.
2—13&23x18 Tandem Williams.
1—36x72 Corliss 50-ton wheel.
1—34x72 Corliss 50-ton wheel.
1—28x60 Allis 1800 frame.
1—22x42 Rice & Sargeant.
1—24x48 Hamilton.
1—18x42 Hamilton Corliss.
1—18x48 Knowlson & Kelly Corliss.
1—18x36 Allis.
1—12x24 Watts Campbell.
1—21x18 Armington & Sims.
2—18½x18 Armington & Sims.
1—18½x18 McIntosh & Seymour.
1—12&20x12 Westinghouse.
2—13&22x13 Westinghouse.
1—14&24x14 Westinghouse.
1—16&27x16 Westinghouse.
2—18&30x16 Westinghouse.
2—16x16 Ball.
2—6x16 Ball & Wood.
1—12x11 McIntosh & Seymour.
2—10x11 Armington & Sims.
1—9x12 Ball.
2—14x16 N. Y. Safety Power.
2—13x18 Harrisburg Ide.
1—8½&12x14 Tandem McIntosh & Seymour.
1—14&23x16 Tandem Ames.
1—13&19x15 Tandem McIntosh & Seymour.
1—14&25x16 Ball & Wood Cross Compound.
1—15&23x17 Tandem McIntosh & Seymour.
1—15&25x16 Erie Ball Cross Compound.
1—24x48 Twin Hamilton Corliss.

WHEEL PRESS

1—60-ton Wheel Press, practically new.

ROSSITER, MacGOVERN & CO.

(INCORPORATED)

FACTORIES
JERSEY CITY, N. J.
ST. LOUIS, MO.

MAIN OFFICE
WHITEHALL BUILDING,
17 BATTERY PLACE, NEW YORK CITY

BRANCH OFFICES
BOSTON, 110 State St.
ST. LOUIS, Mo. Trust Bldg

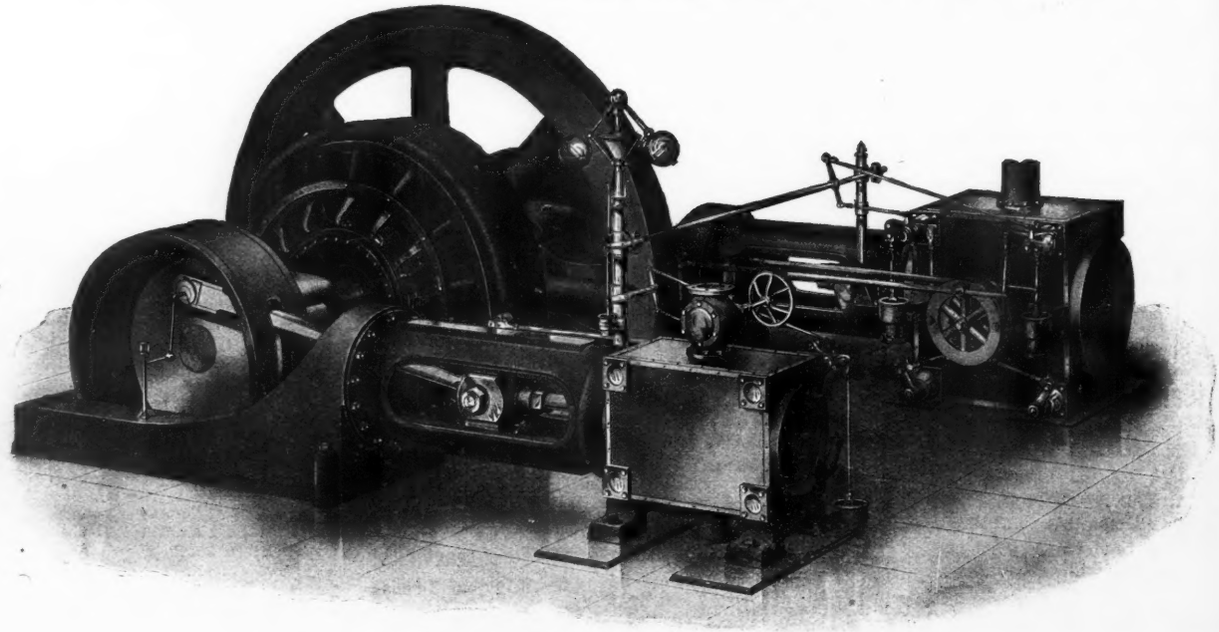
ALLIS-CHALMERS CO.

SUCCESSOR TO

THE EDWARD P. ALLIS CO., MILWAUKEE, WIS. | FRASER & CHALMERS, CHICAGO, ILL. | GATES IRON WORKS, CHICAGO, ILL. | DICKSON M'F'G CO., SCRANTON, PA.

WE MAKE A SPECIALTY OF BUILDING

ELECTRIC LIGHT ENGINES AND STREET RAILWAY ENGINES



REYNOLDS HORIZONTAL CROSS-COMPOUND DIRECT-COUPLED CORLISS ENGINE

We have furnished over 1,000 Reynolds Corliss engines for electric generating purposes.

The largest street railway power stations in the World are equipped with Reynolds Corliss engines.

Reynolds Corliss engines are noted for simplicity in design, durability in construction, and great economy in service.

SOLE BUILDERS OF

NURNBERG GAS ENGINES

RIEDLER PUMPS AND AIR COMPRESSORS

BRANCH OFFICES:
NEW YORK, Broad Exchange Bldg.
BOSTON, Board of Trade Bldg.
PITTSBURG, Frick Building
MINNEAPOLIS, Corn Exchange Bldg.
DENVER, 1649 Tremont Street
SALT LAKE CITY, 209 S.W. Temple St.
SPOKANE, Washington

GENERAL OFFICE
CHICAGO, ILL., U.S.A.
ALLIS-CHALMERS COMPANY 1860 1901

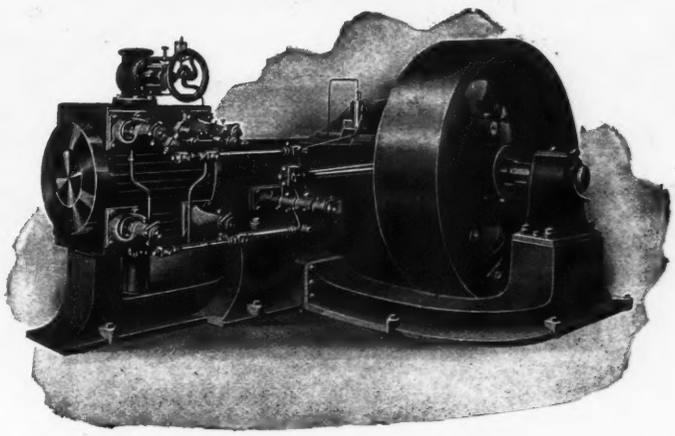
LONDON, ENG., 160 Dashwood House
JOHANNESBURG, South Africa

BRANCH OFFICES:
SAN FRANCISCO, Hayward Bldg.
SEATTLE, Lumber Exchange Bldg.
CHARLOTTE, N. C., Trust Bldg.
NEW ORLEANS, Hennen Bldg.
ATLANTA, GA., Equitable Bldg.
BUTTE, MONT., 51 E. Broadway

HARRISBURG ENGINES

A new and thoroughly developed type affording the highest economy and greatest simplicity ever attained in an automatic Engine.

We build seven styles of Automatic Engines to suit every possible kind of high grade power plant.



Harrisburg Standard Four-Valve Engine.

Complete Steam Plants Equipped with the Schmidt System of Highly Superheated Steam.

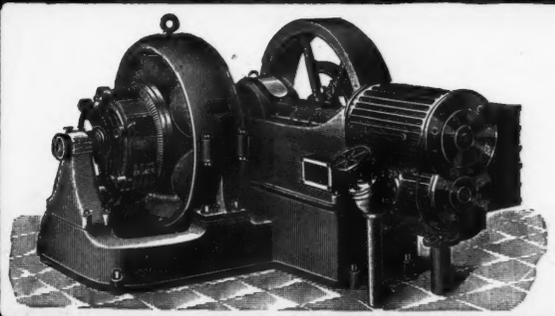
Sizes 10 to 3,000 Horse Power.

Harrisburg Foundry & Machine Works

HARRISBURG, PA.

AMERICAN-BALL DUPLEX COMPOUND ENGINE AND DIRECT CONNECTED GENERATOR

The 20th CENTURY ENGINE SAVES 25%



A Simple Engine wastes 25% of your fuel. The DUPLEX COMPOUND requires no more room, no more attention and no greater cost of maintenance, and its small additional first cost is more than saved every year.

You can't afford to take a simple engine as a gift and pay the extra cost of fuel.

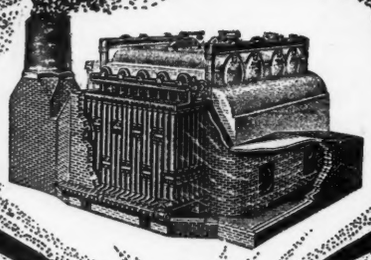
AMERICAN ENGINE COMPANY

NEW YORK OFFICE
No 95 LIBERTY ST.

No 48 RARITAN AVE., BOUND BROOK, N.J.

TRADE PAPER ADV. AGENCY, N.Y.

GREEN'S ECONOMIZER



The Aggregate Saving

It is not alone in the 10 to 20 per cent saving in fuel that ELECTRIC LIGHT, and ELECTRIC LIGHT and POWER PLANTS having a

Green's Economizer

installed in their boiler rooms are benefited, but in the larger heating surface of the boiler secured by the prevention of sedimentary deposit, also the returning feed-water heated above the boiling point rendering boiler repairs less necessary, the reserve of HOT WATER always on hand for emergencies, all make up an aggregate gain that is appreciated by the Plant Owners. How this is accomplished through waste gases entirely is told in our free booklet. The below list of present installations speaks for itself.

LACLEDE POWER CO.,
St. Louis, Mo.

NORTH JERSEY TRACTION CO.,
Newark, N. J.

JERSEY CITY, HOBOKEN & PATERSON ST. RY. CO.,
Hoboken, N. J.

SPRINGFIELD STREET RAILWAY CO.,
Springfield, Mass.

GLEN COVE ELECTRIC CO.,
Glen Cove, L. I.

ST. JOSEPH RAILWAY, LIGHT & POWER CO.,
St. Joseph, Mo.

DENVER TRAMWAY CO.,
Denver, Col.

RHODE ISLAND CO.,
Providence, R. I.

CHICAGO & MILWAUKEE ELECTRIC CO.,
Chicago, Ill.

GEORGIA RAILWAY & ELECTRIC CO.
Atlanta, Ga.

COLUMBUS RAILWAY CO.,
Columbus, O.

ROCHESTER & EASTERN RAPID RAILWAY CO.,
Canandaigua, N. Y.

AUBURN & INTERURBAN RAILWAY CO.,
Auburn, N. Y.

NEWPORT & FALL RIVER STREET RY. CO.,
Newport, R. I.

It is well worth investigating.

The Green Fuel Economizer Co.
Matteawan, N. Y.

Sole Manufacturers in the U. S. A.

DIRECTORY OF ENGINEERS

ELECTRICAL MECHANICAL CONSULTING

CONTRACTORS SPECIAL INTERESTS

ARNOLD ELECTRIC POWER STATION COMPANY,
ENGINEERS, CONTRACTORS.
For Complete Electric Plants.
Results Guaranteed.
SUITE, 1539 MARQUETTE BLDG., CHICAGO.
New York Office, 711 Transit Building.

WM. R. C. CORSON
CONSULTING ENGINEER
Plans, specifications, superintendence of factory, power and lighting installations.
Investigations of electrolysis of underground structures.
Electric machine design.
Reports. Laboratory tests and experiments.
440 CAPITOL AVE., HARTFORD, CT.

THOS. J. McTIGHE, Consulting Engineer.
Mechanical, Reports,
Electrical, Estimates,
Mining, Supervision,
Inventions.
1138 Park Row Building,
13-21 PARK ROW, NEW YORK.

ARVID REUTERDAHL,
CONSULTING STORAGE BATTERY ENGINEER.
67-69-71 FOUNTAIN STREET,
PROVIDENCE, R. I.

BAKER, JOSEPH B.
CONSULTING ELECTRICAL ENGINEER
161 SUMMER STREET, BOSTON, MASS.
Telephone, 1094 Oxford

C. J. FIELD
ENGINEER AND CONTRACTOR
FOR
CONDUITS AND CONDUIT SYSTEMS
Telephone, 5928 Broad
29 BROADWAY - - NEW YORK

New England Engineering Co.
100 BROADWAY, NEW YORK. WATERBURY, CONN.
Electric Railways, Electric Light and Power Plants, Gas and Waterworks, or any other engineering installations built or remodeled.

F. O. RUNYON,
CONSULTING
ELECTRICAL ENGINEER,
122 MARKET STREET, NEWARK, N. J.

W. E. BAKER H. R. BISHOP
W. E. BAKER & CO.
ENGINEERS
ELECTRIC RAILWAYS
170 BROADWAY, NEW YORK

GEO. T. HANCHETT,
CONSULTING AND
ELECTRICAL ENGINEER,
114 LIBERTY STREET, NEW YORK.

POWERS'
CENTRAL STATION STREET RAILWAY DIRECTORIES.
Complete, up-to-date manuals for Financial, Official, Electrical and Mechanical Reference.
THE E. L. POWERS CO., PUBLISHERS,
150 NASSAU ST., NEW YORK.

LE ROY W. STANTON
CONSULTING
TELEPHONE ENGINEER
Plans, Specifications and Supervision of Installation of Complete Telephone Plants. Special Reports on Telephone Properties and Apparatus.
411 Electrical Building, Cleveland, Ohio.

W. S. BARSTOW,
CONSULTING ELECTRICAL and MECHANICAL ENGINEER,
11 BROADWAY, NEW YORK.
Plans and Supervision of Installation of Complete Lighting, Power and Railway Plants. Special Reports on Electrical Properties.
Telephone, 4671 Broad.

EDWARD R. KNOWLES E. E. C. E.
CONSULTING ENGINEER AND ELECTRIC POWER EXPERT
Examinations, Tests and Reports made. Plans and Specifications drawn. Installations laid out and superintended. Machinery Electrically Equipped and Standardized. Expert in Patent Litigation. Inventions developed.
136 LIBERTY ST., NEW YORK CITY

POWER INSTALLATION CO.
ENGINEERS
GEO. F. WESCOTT
ECONOMICAL DEVELOPMENT AND TRANSMISSION
MARINE EXCHANGE BUILDING, BUFFALO
BOSTON OFFICE--719-720 TREMONT TEMPLE

J. H. VAIL,
Mechanical and Electrical Engineer,
Rooms 715-18 Hale Building,
1328 CHESTNUT ST. PHILADELPHIA, PA.
Plans, specifications, contracts, reports. Twenty years' practical experience. Electric lighting. Railways. Power transmission.

BUREAU OF
EXPERT INVESTIGATION
AND
CONSTRUCTION
The investigation of properties, franchises, patents, etc Tests, plans and specifications. Supervision of contracts and management of properties.
35 NASSAU ST., NEW YORK
TELEPHONE 2555 CORTLANDT.

LAMAR LYNDON,
CONSULTING
ELECTRICAL ENGINEER.
Long Distance Power Transmission and Alternating Current Problems a Specialty.
PARK ROW BUILDING, NEW YORK.

FRANK B. RAE,
Electrical and Mechanical Engineer,
ALDRICH COURT, 45 BROADWAY,
NEW YORK.
Designs, Specifications, Estimates, Valuations, Tests and Expert Work. Electric Railways, Lighting and Power Transmissions Steam and Hydraulic Work.

J. G. WHITE & COMPANY,
INCORPORATED,
ENGINEERS, CONTRACTORS,
29 Broadway, New York, N. Y.
LONDON CORRESPONDENTS:
J. G. WHITE & CO., Ltd.,
22A COLLEGE HILL, CANNON STREET.

A. FREDERICK COLLINS
WIRELESS TELEGRAPH ENGINEER
Plans and Specifications; Tests, Measurements and Opinions; Inventions Developed. Experimental Apparatus.
Laboratory, 11 BROADWAY, NEW YORK

ENGINEERS
appearing in this department may be sure that their addresses are in the most conspicuous location for the electrical industry.

C. H. WILMERDING,
CONSULTING ENGINEER,
184 LA SALLE STREET, CHICAGO.
Design and Construction of Electric Lighting and Power Plants. Electrical Equipment of Mills, Factories and Shops. Underground Distributing Systems, Estimates, Reports.

CLASSIFIED INDEX

(*Continued from page 64.*)

Elevating & Conveying Machinery.
Jeffrey Mfg. Co
Electro-Magnets.
Varley Duplex Magnet Co.
Engines (Gas).
Lowell Model Co.
Engines (Steam).
Allis-Chalmers Co.
American Engine Co.
Ball & Wood Co.
Dustin, Chas. E.
Harrisburg Foundry & Machine Wks.
Johnson, Charles F.
Rossiter, MacGovern & Co.
Toomey, Frank.
Engine Indicators.
Ashcroft Engineering Co.
Engine-Stops.
Consolidated Engine-Stop Co
Engineers and Contractors.
Arnold Electric Power Station Co.
Baker & Co., W. E.
Barstow, W. S.
Cahoon, James Blake.

Engineers and Contractors.
Collins, A. Frederick.
Corson, Wm. R. C.
Field, C. J.
Kelly Engineering Co., The John F.
Knowles, Edward R.
Kutsch, L. W.
Lyndon, Lamar.
McTighe, T. J.
New England Engineering Co.
Power Installation Co.
Rae, Frank B.
Reuterdahl, Arvid.
Runyon, F. O.
Stanton, Le Roy W.
Vail, J. H.
Westcott, Geo. F.
White & Co., J. G.
Wilmerding, C. H.
Fans and Fan Motors.
Central Electric Co.
Colonial Fan and Motor Co.
Diehl Mfg Co.
Fort Wayne Electric Works.

Fans and Fan Motors.
General Electric Co.
Gen'l Incandescent Arc Light Co.
Hunter Fan & Motor Co.
Jones & Son, J.
Pacific Electric Co.
Peerless Electric Co.
Robbins & Myers Co.
Rosenberg Co., A.
Sprague Electric Co.
Warren Electric & Specialty Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.
Fan Motor Appliances.
The Coleman Mfg. Co.
Feed Water Heaters.
Stilwell-Bierce & Smith-Vaile Co.
Fire Extinguisher.
Monarch Fire Appliance Co.
Flexible Shafting.
Stow Manufacturing Co.
Fuses.
Chicago Fuse Wire & Mfg. Co.
D. & W. Fuse Co.

Fuses.
Johns-Manville Co., H. W
McIntire Co., The C.
Fuel Economizers.
Green Fuel Economizer Co.
Gaskets.
U. S. Mineral Wool Co.
Gears
New Process Raw Hide Co.
Graphite.
Dixon Crucible Co., Jos.
Globes, Shades, Etc.
Frink, I. P.
Phœnix Glass Co.
Wheeler Reflector Co.
Heating Apparatus.
American Electric Heater Co.
Simplex Electrical Co.
House Goods.
Boston Electric Co.
Central Electric Co.
Ostrander & Co., W. R
Hoisting Machinery.
Jeffrey Mfg. Co.

(*Continued on page 94.*)

MEETS THE REQUIREMENTS

on all systems of circuits, and fits into rigid specifications.

IT DOESN'T COST MUCH, BUT IT'S HIGH CLASS

Complete in all details. Sensitive adjustments and ample contacts.

$3.75, WITH A GOOD DISCOUNT TO DEALERS

SEND FOR CATALOGUE

RUSSELL-TOMLINSON ELEC. CO.

DANBURY, CONN.

The

American Bell Telephone Company,

125 Milk Street, Boston, Mass.

DIVIDENDS

MAY BE INCREASED BY CONNECTING UP YOUR

FARMERS

AND

OUTLYING DISTRICTS

Others are Making their Plants Pay Fair Interest on their Investments that Formerly Showed a Shortage.

NEW FEATURES!

ALL TROUBLE POINTS

ELIMINATED

No Listening Keys
No Clearing-Out Drops
No Ringing keys
No Complications in Your Cord Circuit
No Delays—Always Ready for Business

WE WILL TELL YOU HOW IT'S DONE

WRITE TO

The North Electric Co.

145-155 St. Clair St., CLEVELAND, O. CHICAGO OFFICE 1511 Monadnock Block

CLASSIFIED INDEX

(*Continued from page 93.*)

Igniters (Gas Engine).
Dayton Electrical Mfg. Co.

Incandescent Lamp Coloring.
Eureka Electric Color Co.

Injectors.
Hayden & Derby Mfg. Co.
Lunkenheimer Co., The

Instruments.
Biddle, Jas. G.
Bristol Co.
Bullock Electric Mfg Co.
Gen'l Incandescent Arc Light Co.
Jewell Electrical Instrument Co.
Keystone Electrical InstrumentCo.
Knott Apparatus Co., L. E.
Machado & Roller.
Pignolet, Louis M.
Purdy & Co., J. H.
Stanley Instrument Co.
Wagner Electric Mfg. Co.

Insulators and Insulating Material.
Brookfield Glass Co.
Case Brothers.
Hemingray Glass Co.
Hungerford Electric Mfg. Co.
Massachusetts Chemical Co.
Mica Insulator Co.
Standard Paint Co.
Standard Underground Cable Co.
Standard Vitrified Conduit Co.
Star Porcelain Works.
Sterling Varnish Co.
Steward Mfg. Co., D. M.
Thomas & Sons Co., R.

Junction Boxes.
Bossert Electric Construction Co.
Gen'l Incandescent Arc Light Co

Lamps, Arc.
Adams-Bagnall Electric Co.
Columbia Electric & Mfg. Co.
General Electric Co.
Gen'l Incandescent Arc Light Co.
Helios-Upton Co.
Nernst Lamp Co.
Osborn-Morgan Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co

Lamps, Decorative.
Central Electric Co.
Edison Deco. & Miniature Lamp Dep
Gen'l Incandescent Arc Light Co
Rooney & Westbury Elec. Lamp Co.

Lamps, Incandescent.
Banner Electric Co.
Bryan-Marsh Co.
Columbia Incandescent Lamp Co
Economical Electric Lamp Co.
Economy Electric Co., The
Fort Wayne Electric Works.
Fostoria Incandescent Lamp Co.
General Electric Co.
Gen'l Incandescent Arc Light Co
Independent Incandescent Lamp Co
Lamp Testing Bureau.
Nernst Lamp Co.
New York & Ohio Co.
Phelps Co.
Sawyer-Man Electric Co.
Shelby Electric Co.
Standard Electric Mfg. Co.
Sterling Electrical Mfg. Co.
Warren Electric & Specialty Co.
Western Electric Co.

Launches.
Electric Launch Co.

Lighting Plants.
Bullock Electric Mfg. Co
Christensen Engineering Co
Crocker-Wheeler Co.
Fort Wayne Electric Works.
Reuterdahl Electric Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Lightning Arresters.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Lubricators.
Lunkenheimer Co., The
Siegrist Lubricator Co.

Lumber, Creosoted
Wyckoff Pipe & Creosoting Co.

Machine Tools and Machinery.
Jeffrey Mfg. Co.
Morse Twist Drill & Machine Co.
New England Butt Co.
Seneca Falls Mfg. Co

Mast Arms.
T. H. Brady.

Meters.
Diamond Meter Co.
Duncan Electric Manufacturing Co
Fort Wayne Electric Works.
Stanley Instrument Co.
Westinghouse Electric & Mfg. Co.

Mica.
Mica Insulator Co
Munsell, Eugene.
Sills-Eddy Mica Co.

Model Makers.
Franklin Model Shop.
Parsell & Weed.

Name-Plates.
The Schwerdtle Stamp Co.

Nippers and Pliers.
Smith & Hemenway Co.
Utica Drop Forge & Tool Co

Paint.
Massachusetts Chemical Co.
Standard Paint Co.

Patent Solicitors.
Benjamin, Geo. H.
Duvall, Edw. S.
Siggers & Siggers.

Pinions
New Process Raw Hide Co.

Pipe Covering.
U. S. Mineral Wool Co.

Platinum.
American Platinum Works.
Baker & Co
Croselmire & Ackor.

Pulley Covering.
Rope Fibre Pulley Covering Co.

Poles, Brackets, Pins, Ties, Cross-Arms, Climbers, Etc.
Donnelly, John
Eccleston Lumber Co.
Fowler, John H.
Klein & Sons, Mathias.
Phelan, D. W.
Standard Pole & Tie Co
Valentine-Clark Co.
Wyckoff Pipe & Creosoting Co.

Pumps (Electric Driven).
Stilwell-Bierce & Smith-Vaile Co

Rails.
Johnson, Charles F.

Rail-Bonds.
Roebling Sons Co., John A.

Railway Car Lighting.
Consolidated Railway, Electric Lighting & Equipment Co.

Railway Specialties (Electric).
Bunnell & Co., J. H.
Central Electric Co.
Continuous Rail Joint Co. of America.
Electric Appliance Co.
General Electric Co.
Kinsman Electric & Railway Supply Co.
Stuart-Howland Co.
Westinghouse Electric & Mfg. Co.

Reflectors.
Frink, I. P.
Wheeler Reflector Co

Repairs.
Chicago Edison Co.

Replacers Incandescent Lamp.
Incandescent Electric Light Manipulator Co.

Rheostats.
Cutler-Hammer Mfg. Co.
Cutter Electrical & Mfg. Co.
Gen'l Incandescent Arc Light Co.
Wirt Electric Co.

Schools.
Electrical Engineer Institute of Correspondence Instruction.
Internat'l Correspondence Schools.
Michigan College of Mines.
McGill University.
University of Wisconsin.

(*Continued on page 96.*)

SWEDISH-AMERICAN TELEPHONE CO.
CHICAGO, ILL.
Manufacturers of Superior Telephone Apparatus
CORRESPONDENCE SOLICITED

DE VEAU
TRADE MARK
Complete new catalogue mailed upon request
De Veau Telephone Mfg. Co.
27 Rose Street, NEW YORK

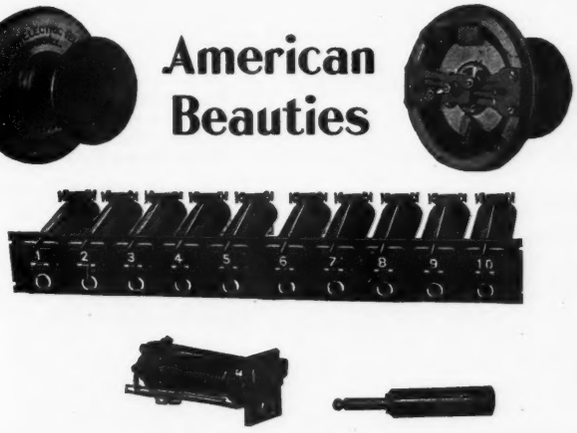
BELL of Hayward, Wis.
Telephones and Switchboards remodeled on approved lines.
A good 'Phone at the right price. We promote or build.

Western Telephone Mfg. Co.
Will make its name a Synonym for PERFECTION IN TELEPHONE APPARATUS
Factories, Winthrop Harbor, Ill
Offices, Chicago, Ill.
Ask about our New Lamp Clearing-Out System.

FARR TELEPHONES
FOR PRIVATE LINES EXCHANGES COUNTRY LINES AND FACTORIES
TELEPHONE SUPPLIES, BRACKETS, WIRE & INSULATORS
FARR TELEPHONE AND CONST. SUPPLY CO.
118 & 120 W. Jackson Blvd. - CHICAGO

THE VIADUCT CO.
Baltimore, Md.
MAKE TELEPHONES AND EVERYTHING ELECTRICAL

TELEPHONE SERVICE IS THE QUICKEST MESSENGER
Rates in Manhattan:
Residence from $4 a month.
Business from $5 a month.
One-Year Contracts.
Monthly Payments.
New York Telephone Co.
15 Dey Street.
111 West 38th Street.
220 West 124th Street.

American Beauties

Bell Express Style
One to two hundred to the operator
American Electric Telephone Co.
Chicago, Ill.

Switch-boards of Quality
The Vought-Berger Co.
MAKERS OF
Telephones & Switchboards
LA CROSSE, WIS., U. S. A.
Get a Pendant

AUTOMATIC TELEPHONES
PRIVACY
PROMPTNESS
PRECISION
PROFITS
Automatic Electric Co., Chicago, U. S. A.

Yards
Pinconning, Mich.
Green Bay, Wis.
New London, Wis.
Prentice, Wis.

CEDAR POLES

THE
Valentine-Clark Co.

General Office
805 Gaff Bldg., 234 La Salle St., Chicago
Established 1892
Poles exclusively

Tempting Providence! Sending valuable men out on Crossarms that are full of knots. You deserve to be tied up with law suits.

Get Florida Pine Crossarms from

The Standard Pole & Tie Co.
502 Venezuela Bldg., NEW YORK CITY
Wilmington, N. C. Brooksville, Fla.

IDAHO WISCONSIN MICHIGAN
CEDAR POLES AND TIES
JOHN H. FOWLER FOWLER-JACOBS CO.
YARDS
WASHBURN, WIS.
PLUMMER, WIS.
BRULE, WIS.
VAN BUSKIRK, WIS.
URSON, WIS.
GENERAL OFFICE
1705 FISHER BUILDING
CHICAGO
BRANCH OFFICES
WASHBURN, WIS., AND SPOKANE, WASH.

THE BEST POLES IN THE WORLD
Southern Cedar Poles
D. W. PHELAN NO ROTTEN BUTTS TRY THEM 277 Broadway NEW YORK

POLES { LONG LEAF YELLOW PINE
OCTAGONAL AND SQUARE
JUNIPER OR SOUTHERN WHITE CEDAR
CHESTNUT AND CYPRESS
CROSS-ARMS
Prompt Deliveries from Stock New York City Yard or Direct from Mills.
MANUFACTURED BY
ECCLESTON LUMBER CO.
29 BROADWAY, NEW YORK.

KLEIN'S CLIMBERS

Linemen's Tools
Catalogue Free. Send for one.
MATHIAS KLEIN & SONS
87-89 W. Van Buren St., CHICAGO, ILL.

The "Button" Type Telephone Transmitter

Better than the "solid back" for long heavy lines.

SEND FOR BOOKLET

The Fahnestock Transmitter Company
74 Cortlandt Street, New York City

CLASSIFIED INDEX

(*Continued from page 94.*)

Seals.
The Schwerdtle Stamp Co.

Signs (Electric).
Pacific Electric Co.

Slate.
Fleming Slate Co.

Sockets.
H. T. Paiste Co.

Soldering Sticks and Paste.
Allen & Co., L. B.
Burnley Battery & Mfg. Co.

Specialties.
Boston Electric Co.
Crouse-Hinds Electric Co.
Electric Contract Co.
Gen'l Incandescent Arc Light Co.
Hubbell, Harvey.
Incan. Elec. Light Manipulator Co.
Lyon Metallic Mfg. Co.
Marshall-Sanders Co.
Phelps Co.
Yost Electric Mfg. Co.

Speed Limits.
Consolidated Engine-Stop Co.

Steam Heating.
American District Steam Co.

Steam Specialties.
Lunkenheimer Co., The.
Robertson & Sons, Jas. L.
U. S. Mineral Wool Co.

Steel Spring Wire.
Barnes Co., The Wallace.
Cary Spring Works.

Steel Stamps.
The Schwerdtle Stamp Co.

Stencils.
The Schwerdtle Stamp Co.

Storage Batteries.
American Battery Co.
Dayton Electrical Mfg. Co.
Electric Storage Battery Co.
Gould Storage Battery Co.
Helios-Upton Co.
National Battery Co.
Reuterdahl Electric Co.
Smith Storage Battery Co.
United States Battery Co.

Switchboards.
Bossert Electric Construction Co.
Bullock Electric Mfg. Co.
Ericsson Telephone Co.
Eyanson & Co., Geo. T.
Fort Wayne Electric Works.
Gen'l Incandescent Arc Light Co.
Wagner Electric Mfg. Co.
Western Electric Co.

Switches, Etc.
Abbott, Eugene B.
Central Electric Co.
Cutter Electrical & Mfg. Co.
Eyanson & Co., Geo. T.
General Electric Co.
Gen'l Incandescent Arc Light Co.
Hart & Hegeman Mfg. Co.
Hart Mfg. Co.
Hill Electric Co., W. S.
Marshall-Sanders Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Tape and Splicing Compound.
Massachusetts Chemical Co.
Okonite Co.

Telegraph Supplies.
Bunnell & Co., J. H.
Stuart-Howland Co.

Telephones.
American Bell Telephone Co.
American Electric Telephone Co.
Automatic Electric Co.
Central Electric Co.
De Veau Telephone Mfg. Co.
Ericsson Telephone Co.
Farr Telephone & Construction Supply Co.
Fahnestock Transmitter Co.
Kellogg Switchboard & Supply Co.
New York Telephone Co.

Telephones.
North Electric Co.
Stanley & Patterson.
Stromberg-Carlson Telephone Mfg. Co.
Swedish-American Telephone Co.
Viaduct Mfg. Co.
Vought-Berger Co.
Western Telephone Mfg. Co.

Testing Bureau.
Lamp Testing Bureau

Ties, Cross-Arms, Brackets, Pins, Climbers, Etc.
Central Electric Co
Donnelly, John
Eccleston Lumber Co.
Fowler, John H.
Klein & Son, Mathias.
Lindsley Brothers Co.
Standard Pole & Tie Co.
Valentine-Clark Co

Time Stamps, Automatic and Calculating.
Automatic Time Stamp Co.

Tools.
Morse Twist Drill Co.
Smith & Hemenway Co.
Utica Drop Forge & Tool Co.

Transformers.
Christensen Engineering Co.
Fort Wayne Electric Works
New York & Ohio Co.
Stanley Electric Mfg. Co.
Valentine-Clark Co.
Vindex Electric Co.
Wagner Electric Mfg. Co.
Warren Electric & Specialty Co.
Western Electrical Supply Co
Westinghouse Electric & Mfg. Co.

Turbine Governors.
Lombard Water-Wheel Gov. Co.
Lunkenheimer Co., The

Valves.
Lunkenheimer Co., The.

Varnish, Insulating.
Massachusetts Chemical Co.
Sterling Varnish Co.

Vises.
Utica Drop Forge & Tool Co.

Water-Wheels.
Leffel & Co., Jas.
Risdon-Alcott Turbine Co.
Stilwell-Bierce & Smith-Vaile Co.

Water-Wheel Governors.
Lombard Water-Wheel Gov. Co.

Whistles.
Lunkenheimer Co., The.

Wires and Cables.
American Electrical Works.
American Insulated Wire & Cable Co.
American Steel & Wire Co.
Atlantic Insulated Wire & Cable Co
Bridgeport Brass Co.
Brixey, W. R.
Central Electric Co.
Chicago Insulated Wire Co.
Collyer Insulated Wire Co.
Crescent Insulated Wire and Cable Co.
Electric Appliance Co.
Empire Wire Co.
General Electric Co.
Hazard Mfg. Co.
India Rubber and Gutta Percha Insulating Co.
Magnet Wire Co.
Montauk Fire-Detecting Wire Co.
National Conduit & Cable Co.
National India Rubber Co.
New York Insulated Wire Co.
Okonite Co., The.
Phillips Insulated Wire Co.
Phosphor Bronze Smelting Co., Ltd.
Roebling's Sons Co., John A.
Safety Insulated Wire & Cable Co.
Simplex Electrical Co.
Standard Underground Cable Co.
Waclark Wire Co.
Western Electric Co.

NO we are not the only manufacturers of Telephones.

BUT we are the only manufacturers of the Kellogg Telephone Apparatus which has set the standard of excellence in Telephones throughout the world.

The Kellogg Telephone of to-day represents one of the highest achievements of American invention and design.

In a word, if you want perfection in this line—and perfection is rare—write for quotations to the

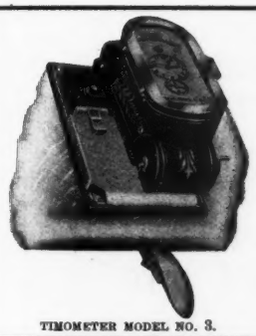
KELLOGG SWITCHBOARD & SUPPLY CO.

GREEN AND CONGRESS STREETS
CHICAGO

346 Broadway
New York

Electric Building
Cleveland

Keystone Electric Building
Philadelphia



TIMOMETER MODEL NO. 3.

THE
TIMOMETER
Or Calculating Automatic Time Stamp

fits into Switchboard and records the hour, minute and second, date when a toll line telephonic conversation begins and ends. It records and calculates to a second the lapsed or intervening time.

The Automatic Time Stamp Co.
160 Congress St., Boston, Mass., U. S. A.

JUST PUBLISHED

All about the Telephone
A • B • C
of the
TELEPHONE
A PRACTICAL TREATISE
By J. E. HOMANS, A. M.

352 pages. 269 illus. Size, 5x7½ inches
with generously good binding

Price One Dollar. Postpaid to any Address

Electrical Review Publishing Co.
13-21 Park Row, New York City, U. S. A.
Box 339

YES

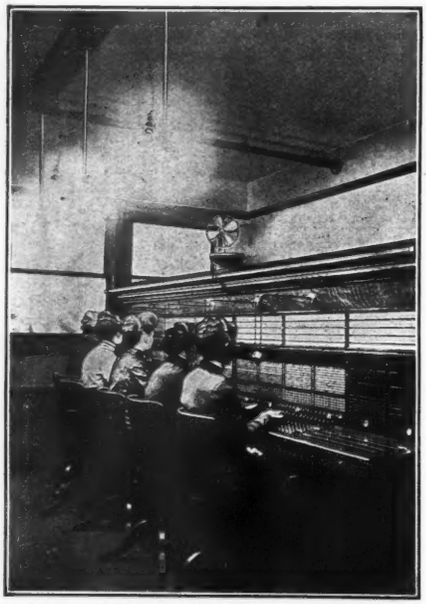
H. B. HEWITT, STATE REPRESENTATIVE, KEITHSBURG, ILL.
Bulletin No. 2-F is a complete treatise on Bridging telephones and small generator call switchboards.

STROMBERG-CARLSON TELEPHONE M'F'G CO.

GENERAL & EASTERN SALES OFFICE,
ROCHESTER, N. Y.

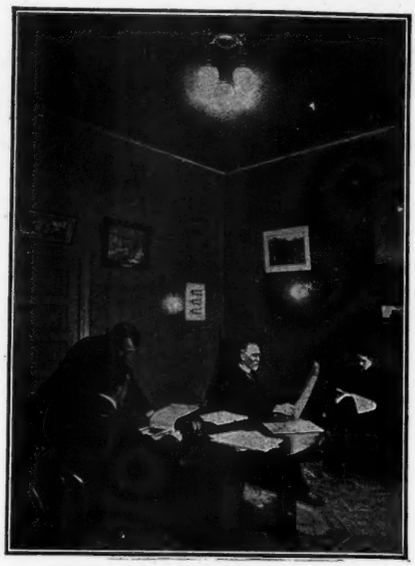
SALES DEPARTMENT,
CHICAGO, ILL.

The Nernst
Quality of Light



Telephone Exchange illuminated by Nernst Lamps

is especially valuable where the conditions call for perfect steadiness and softness, free from any irritating glare.



Reading Room illuminated by Nernst Lamps

Any Electrical Supply Dealer

will mail you Booklet No. 2 describing the many advantages of The Nernst, both in efficiency and economy, as compared with the ordinary incandescent,

or address nearest sales office of Nernst Lamp Co.

Sales Offices: Pittsburgh, Fayette Street and Garrison Place; New York, Equitable Building; Boston, Board of Trade Building; Philadelphia, Real Estate Trust Building; Chicago, National Life Building.

THE issues of the Electrical Review, MAY 30 and JUNE 6 will contain early, accurate and full reports of the National Electric Light Association's meeting, which will undoubtedly be one of the most important ever held by the Association.

Of all technical literature these Convention issues are most carefully studied by all who have relations with the electrical and mechanical pursuits in all parts of the world. Because of the great strides in the recent past in electrical engineering the issues for 1903 will be especially noteworthy, and largely increased circulation will be given them over the regular numbers.

ELECTRICAL REVIEW

40 Dearborn Street CHICAGO

13 Park Row NEW YORK

42 Old Broad Street LONDON

KELLOGG
PROGRESS FIGURES

Orders for Kellogg Telephones alone for the first quarter of 1903 show an increase over the corresponding period in 1902 of **239 per cent**

Shipments of telephones in the first quarter of 1903 exceed the same period in 1902 by **255 per cent**

In the manufacture of telephone sets in the first quarter of the present year there has been an increase over last year of **249 per cent**

This tremendous increase in the demand for Kellogg Apparatus has kept the immense new factory running overtime, yet all orders thus far for standard instruments have been promptly filled.

Get our latest quotations on Magneto and Common Battery Telephones, and when you consider that our apparatus is held as the standard of excellence all over the world you will see that our prices are the cheapest after all.

Kellogg Switchboard & Supply Company

Green and Congress Streets, CHICAGO

346 Broadway
NEW YORK

Electric Build ng
CLEVELAND

Keystone Telephone Bldg.
PHILADELPHIA

Replacing ordinary incandescents with Nernst Lamps

When the ordinary incandescent lamps in this reading-room had been replaced by

The Nernst

there were no longer complaints of the eyes having "that tired feeling," after reading for a short time.

* * *

Any Electrical Supply Dealer

will send you illustrated Book No. 2 telling why, or address nearest sales office of Nernst Lamp Co.

Sales Offices: Pittsburgh, Fayette Street and Garrison Place: New York, Equitable Building: Boston, Board of Trade Building: Philadelphia, Real Estate Trust Building: Chicago, National Life Building.

Reading-Room Lighted by Nernst Lamps

THE issue of the Electrical Review MAY 23 will be distributed at the Convention of the National Electric Light Association; the issues MAY 30 and JUNE 6 will contain early, accurate and full reports of the meeting, which will undoubtedly be one of the most important ever held by the association.

Of all technical literature these Convention issues are most carefully studied by all who have relations with the electrical and mechanical pursuits in all parts of the world. Because of the great strides in the recent past in electrical engineering the issues for 1903 will be especially noteworthy, and largely increased circulation will be given them over the regular numbers.

ELECTRICAL REVIEW

40 Dearborn Street CHICAGO

13 Park Row NEW YORK

42 Old Broad Street LONDON

Westinghouse Instruments

The Recognized Standards

For Alternating and Direct Current Circuits

Type G Voltmeter, Alternating Current Illuminated Dial

Type G Ammeter, Alternating Current Illuminated Dial

Type F Voltmeter, Alternating Current

Type F Ammeter, Alternating Current

Type F Single-Phase Wattmeter, Alternating Current

Type F Polyphase Wattmeter, Alternating Current

Type E Voltmeter, Direct Current Illuminated Dial

Type E Ammeter, Direct Current Illuminated Dial

Type D Voltmeter, Direct Current

Type D Ammeter, Direct Current

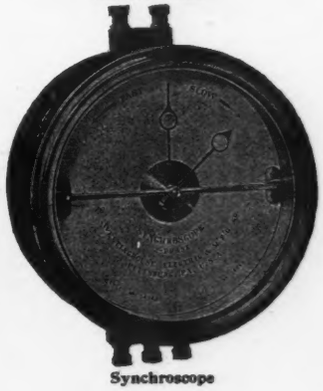
Type C Voltmeter, Alternating and Direct Current

Type C Ammeter, Alternating and Direct Current

Frequency Meter

Power Factor Meter

Static Ground Detector



Synchroscope

For Particulars Address

Westinghouse Electric & Mfg. Co.

Sales Offices in all Large Cities **Pittsburg, Pa.**

TRADE MARK

CRESCENT INSULATED WIRE & CABLE CO. TRENTON, N. J.

CRESCENT RUBBER INSULATED WIRES AND CABLES

National Code Standard

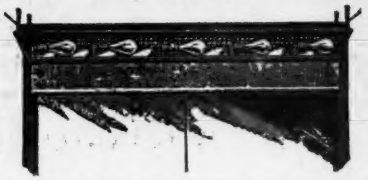
CRESCENT INSULATED WIRE AND CABLE CO.

New York Office, 53 Barclay St. · Main Office and Factory, TRENTON, N. J.

IDEAL WINDOW LIGHTING

Frink's Special Store Window Reflector.

PATENTED APRIL 20, 1897; FEB. 21, 1899.



Adopted by Leading Stores throughout the country, as being the most perfect fixture for its purpose.

Ninety-nine per cent of store windows are imperfectly lighted. The only right way is to light from the top, near the glass, reflecting the light downward and inward. This is the most perfect and economical fixture for this method. Estimates and full particulars on request.

I. P. FRINK, 551 Pearl Street, NEW YORK

Chicago Insulated Wire Company

High-Grade Weather-Proof, Magnet, Office, Annunciator Wire & Galvanized Steel Strand

Chicago Office 1g Marine Building

Factory Sycamore, Illinois

IT WILL PAY YOU TO ASK US FOR PRICES AND SAMPLES OF

WEATHERPROOF COPPER WIRE

WHENEVER YOU ARE IN THE MARKET A LARGE STOCK CARRIED

American Insulated Wire and Cable Co.

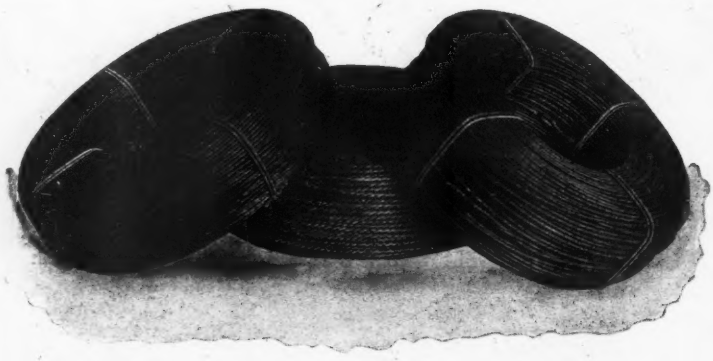
241-247 SO. JEFFERSON ST.

CHICAGO

EMPIRE WIRE CO.

92 WILLIAM ST., NEW YORK

BARE AND TINNED COPPER WIRE MAGNET WIRE



If you desire prices on the best grade of

Insulated Wire of any kind

Write to

John A. Roebling's Sons Co.

TRENTON, N. J.

NATIONAL ELECTRICAL CODE STANDARD

WEATHER-PROOF TRADE MARK "O.K." LIKE AND HOUSE WIRES

"O. K." WEATHER-PROOF, SLOW-BURNING WEATHER-PROOF, AND SLOW-BURNING WIRE.

PRICES AND SAMPLES ON APPLICATION.

PHILLIPS INSULATED WIRE CO.

OFFICE AND FACTORY: PAWTUCKET, R. I.

Specify

LUNKENHEIMER Regrinding Valves

"Last as long as the pipe"

Samples Free

Will carry 200 per cent more lead than all so-called doped or treated brushes. If the brush should heat there is no dope to ooze out and black or gum the commutator. Our "High Grade" Brush is very much lower in resistance than any other brush on the market, therefore will carry 200 per cent more lead, and is not a treated brush.

SPEER CARBON COMPANY

ST. MARYS, PA.

For Electricians

It is the only practicable nail puller on the market.

Can be conveniently carried in the pocket, and used in connection with any claw hammer.

The price is low, and brings it within reach of all.

For particulars, send for our Green Book of Hardware Specialties.

SMITH & HEMENWAY CO. CORP., Mfrs. of Cutlery and Hardware Specialties.
ERICSSON TELEPHONE CO., Mfrs. & Importers of Telephones.
UTICA DROP FORGE & TOOL CO., Mfrs. of Nippers and Pliers.

296 Broadway - - New York City

NEW YORK